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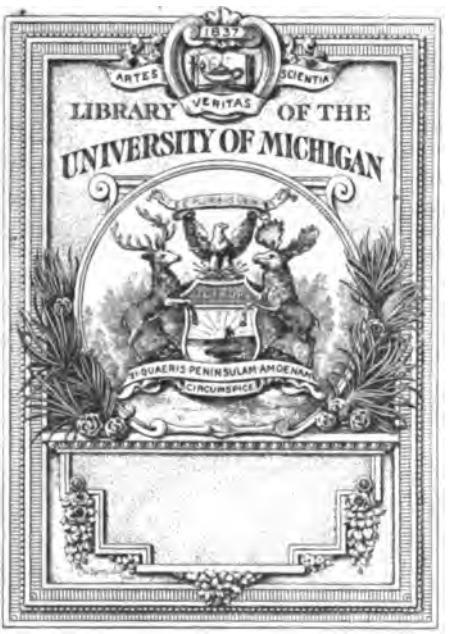

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WORLD'S COLUMBIAN EXPOSITION,

CHICAGO, ILL., 1893.

REPORT

OF THE

COMMITTEE ON AWARDS

OF THE

WORLD'S COLUMBIAN COMMISSION.

U.S. Committee on awards.

SPECIAL REPORTS

UPON

SPECIAL SUBJECTS OR GROUPS.

IN TWO VOLUMES.

Vol. I.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1901.

WORLD'S COLUMBIAN COMMISSION.

Resolved by the Senate (the House of Representatives concurring), That there be printed three thousand five hundred copies of so much of the report of the committee on awards of the World's Columbian Commission as is contained in the special reports upon special subjects or groups as were prepared by expert judges authorized to act by the World's Columbian Commission, its executive committee on awards, the committee on final report, or the board of reference and control, of which one thousand shall be for the use of the Senate, two thousand for the use of the House of Representatives, and five hundred for distribution by the Department of State.

Passed the Senate May 31, 1900. Passed the House of Representatives March 1, 1901. (Amendment incorporated in the foregoing.)

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ARCHITECTURE OF THE WORLD'S COLUMBIAN EXPOSITION.

BY

HENRY VAN BRUNT, Judge.

ARCHITECTURE OF THE WORLD'S COLUMBIAN EXPOSITION.

By HENRY VAN BRUNT, *Judge.*

All historical architecture is representative of the era which produced it. In each case its general form and the character of its detail, especially its decorative detail, are developed from the spirit and essential characteristics of its contemporary phase of civilization or semibarbarism. But modern architecture has become so conscious of itself that it is in a measure sophisticated, affected, insincere, and therefore apparently not so accurately representative of its era; and yet the twentieth century will read in it the essential genius of our times as clearly as we may now read that of the eighteenth century in the work of the younger Mansart in France, and that of Gibbs, Hawksmoor, and Vanbrugh in England.

It is from this peculiarly representative function that the architecture of the World's Columbian Exposition must derive, if not its greatest present interest, at least its importance in the history of civilization. Within our narrow limits of criticism and from our far too proximate point of view we may survey and judge this extraordinary demonstration of art; but the real importance of it to us resides in the fact that we shall be judged by it when sufficient distance of time or space shall have intervened to place the whole vast composition in just perspective.

The present report does not properly embrace the historical record of the practical conditions and of the organization under which this demonstration became possible, nor yet the story of how the principal architects, painters, and sculptors of the country were brought together in one of the most fruitful collaborations of history to produce it.

This field will doubtless be adequately covered by correct official statements. But it is a necessary part of the survey we are taking of the architecture of the Exposition to note the fact that the architects of the principal buildings were first gathered together at Chicago on January 10, 1891; that on February 20 they met again, bringing their preliminary sketches; that twenty-six months afterwards the World's Fair was opened with about fifty completed and occupied buildings, covering an aggregate of 6,500,000 square feet, erected under the construction department of the Exposition; with thirty buildings, covering 40,000 square feet, erected by the States of the Union; with twenty

buildings, covering 300,000 square feet, erected by foreign governments, and with between fifty and sixty, covering more than a million square feet, erected by parties to whom concessions had been granted in the Midway Plaisance and elsewhere. The work accomplished in this period of gigantic and harmonious effort included also all the complicated underground work necessary in the connection of electric lighting and power cables, in the distribution of gas and water, and in the installation of a complete and perfect sewerage system; all the grading and construction work involved in the establishment of basin, canals, terraces, balustrades, bridges, landing stairs, vases, fountains, monumental columns, and groups of statuary; all the ornamental landscape work and gardening necessary to bring the artificial lagoon and its islands into harmony with the general architectural scheme. The artificial and natural landscape and water work of Jackson Park was not merely accessory to the great buildings which occupied the higher plateaus established for them, but an essential part of the design as a whole. Buildings and grounds were developed together and in closest sympathy. They can hardly be judged apart. In a few short months art and energy created on a sandy waste on the margin of Lake Michigan a city of monumental architecture such as no emperor or king of ancient or modern times ever dreamed of.

If all this was emergency architecture, struck off in the heat of enthusiastic zeal, there was no element of accident or chance about it. Behind it was the initial force furnished by the wealth and enterprise of a sympathetic people, and the deliberation of concentrated energy and skill. The architects, engineers, painters, sculptors, and gardeners, summoned from every part of the country, were representative men, and their work, done under the most favorable possible conditions, was representative of the best capacities of the nation. We seem, therefore, to be justified in treating of this great architectural manifestation, not as phenomenal or exceptional, but as a normal expression of our civilization in its best estate. He who undertakes to criticise the buildings of the Exposition is criticising also the spirit and genius of the people which made them possible. Architecture, under the common and ordinary conditions of development, to the extent that it is subject to the personal caprice of the architect, under requirements and limitations imposed by the individual owner, can not be so representative as architecture resulting from the zealous enthusiasm of a whole people desiring to express themselves worthily before the world, and interposing no obstacles to its harmonious development.

The central and principal architectural expression of the Exposition of 1893 is in the court of honor, including not only the great basin and the buildings immediately surrounding it, but the forecourt or entrance court on the western or landward side of the court of honor, where the railroad systems debouch. The distinction enjoyed by this

great group of buildings arises from the important fact that, first, the artificial topography of the place was made for the buildings and the buildings were made for it, and, second, that the buildings themselves were developed in an architectural collaboration sufficiently close and intimate to eliminate from each building any personal element or idiosyncrasy which might interfere with the harmony of the composition as a whole. Each design yielded something of the individuality, which under other circumstances it would naturally have assumed, for the sake of artistic unity. But this process of elimination was not carried so far as to secure the necessary harmony of feeling by a monotonous uniformity which would have been tedious and unimaginative. This is the secret of the success with which this great architectural combination appealed to the interest and sympathy of the public. From the point of view of the official judge, that ideal variety in unity, which is the most difficult of all artistic balances to obtain without an overweight of capricious fancy on the one hand or of dull conformity on the other, seems to have been at last secured in this great national effort. The inspiration of the whole composition evidently came from the forums, basilicas, villas, and baths of the Roman Empire; but in none of the great centers of imperial wealth, power, and civilization in ancient or modern times has a demonstration been made so vast and so connected.

The practical means by which the great principle of variety in unity in art found expression in the Exposition of Columbus was evidently very simple. The terminal building, forming the west end of the double court; the peristyle and water-gate with its two wings (the casino and the musical pavilion), which closed it on the east toward the lake; the agricultural palace and that of the mechanic arts, with their connecting peristyle, forming the subsidiary court of the obelisk, which bound it on the south; the buildings of liberal arts, electricity and mines, which inclosed it on the north; and, finally, the administration building, the monumental vestibule of the Exposition, which stood in the center of the great quadrangle, dividing the court of entrance from the court of honor; all these great structures had four leading features in common: first, they were all expressed in terms of strictly classic architecture according to the Romans, or according to its direct derivatives in the Renaissance; second, the order which is the leading motif of design in each was limited to a uniform height of 60 feet to the top of cornice; third, a covered ambulatory was established in each behind an open screen of columns, or piers, or arches, at least along the court frontage; and fourth, each design was developed on a common module or unit of dimensions not greatly varying from 25 feet. Another element, unconsciously working for unity in all the exhibition buildings, was the effect of the plan of these buildings upon the elevations.

In adjusting the vast areas of space necessary to be covered by these

structures each architect found it necessary to establish longitudinally a central nave, predominating in height and width over all subdivisions, crossed in the middle of the plan by a transept of equal importance. The crossing of these predominating features in all architectural compositions is the natural point for a corresponding culmination of exterior expression in dome or tower. But by reason of the vastness of the area occupied in each case any central architectural expression of this sort would be too remote from the four façades to compose with them in any orderly or natural manner. As seen from the forecourt of St. Peters, the façade of Carlo Maderno masks the dome of Michael Angelo behind it. It was not fitting to commit this grave error of design a second time. Therefore in the center of each of the four façades of each building, where nave or transept impinged, there naturally occurred a predominating pavilion as a monumental porch, either in the form of a circular temple, covered by a dome, with a prostyle, as in agriculture, or in the form of a round or square portico flanked by towers, as in mechanic arts, or like a triumphal arch, as in liberal arts and mines, and in the two peristyle screens, or as a niche or hemicycle, as in electricity. These central features, with the subordinate corner pavilions, which naturally occurred in all these structures, combined under the four technical conditions common to all the buildings, were further aided in the work of unification by a spirit of mutual conciliation among the architects, each of whom found by experience that it was necessary for him in the work of collaboration to essentially modify or to entirely abandon parts of his design which by contrast or contiguity injured his neighbors.

Apart from these limitations, each architect developed his work according to his personal feeling, either unconsciously individualizing his design by the operation of the personal equation, or consciously, in the effort to express the especial purposes of his building in his architecture. This conscious effort to differentiate the buildings according to their use is extremely interesting and instructive in its results.

Every architect employed on the greater buildings of the Exposition naturally desires to produce not merely a work intrinsically beautiful because of the just adaptation of certain classic or romantic, academic or archeological formulas to certain structural conditions, but to permit the especial purpose of his building in some way to vary this formula and confer distinction and appropriate character on his design. In this great experiment the fact was illustrated by the greater buildings that certain objects, such as the liberal and mechanic arts, agriculture, transportation, the science of government, music, could not be expressed in the technical part of design. On the other hand, it seemed to be proved that structure itself, as well as the decoration of structure, could express horticulture by long stretches of low

glazed galleries and a wide spreading dome of glass; that a free use of the technical qualities of Romanesque could tell the spectator, as soon as he approached another building, that it was devoted to the illustration of the industries of the sea; that a modern windowless building of pure Greek architecture could be intended only for an exhibition of fine arts; that another modern building, constructed on the main lines of the central hall of the baths of Caracalla, with vast broadly spreading arches and loggias, wide open for constant ingress and egress, could only be the monumental terminal of a great railway system with its offices of public comfort; that still another, differentiated from the rest of the classic neighborhood in which it occurred by a marked predominance of vertical lines, by a multiplication of tall campaniles, by a certain quality of delicate nervousness, as it were, of animation and quickness of movement, as contrasted with the unbroken horizontal lines and the severe repose of the other great monuments, must have been inspired by the idea of electricity; and that another, its nearest neighbor, by a ponderous simplicity and largeness of scale, must have been intended for the display of coarser industries and products, such as mines and mining.

It is not unpleasant, moreover, to fancy that we can detect the essentially feminine element in the design of the women's building. The other buildings, being less able to express their several purposes by a variation of the technique, in their effort to assume especial character, relieved from the elegant vacancy of a merely correct academical design, could only avail themselves of the poetic allegories, illustrations, and symbols, furnished by sculpture, painting, inscriptions, used as aids to architectural effect.

Another element of differentiation in the architecture of the greater buildings resided in the difference of the classic formula, used in each as the base of design. Thus Mr. Hunt preferred to model the administration building on the lines of the French Renaissance, as inculcated in the École des Beaux Arts; Messrs. Peabody and Stearns very happily allowed the quality of the Renaissance which they used in the palace of mechanic arts or machinery hall to be colored by Spanish examples, recalling the country of Ferdinand and Isabella and Columbus; Messrs. McKim, Mead & White, in the palace of Agriculture, expressed themselves in the purest art of the Roman Empire, such as was seen on the Palatine Mount and in the imperial villas and baths; Mr. Post's vast building was in modern French Renaissance, such as occurred in the buildings of the last Paris Exposition, the eight porches being modeled after the triumphal arches of the Romans; Messrs. Van Brunt & Howe permitted the architecture of the electricity building to be affected by the freer French classic of the sixteenth century, the Château of Chambord of the time of Francis I offering suggestions of detail mainly in the fantastic skylines and in the great apsidal projections of the north front toward the lagoon; the struc-

tural scheme of the mines building imposed upon Mr. Beman a very modern (and, in the best sense, an American) interpretation of the classic formula, more influenced, however, by Italian than by any other historical examples; Messrs. Adler & Sullivan made a very wide departure from classic principles in designing the transportation building according to oriental motifs, used in such a manner, however, that if these artists had not been familiar with Byzantine or Romanesque forms, their design would have assumed a character entirely different from that which they actually developed; Mr. Jenney's horticultural building was in free Italian Renaissance somewhat after the manner of Sansovino in the treasury of St. Mark; Mr. Whitehouse's festival hall was fundamentally Greek in character; Miss Hayden's women's building was modeled after an Italian villa of the sixteenth century; Mr. Cobb, in his fisheries building, used a Romanesque motif, such as appears in the monastic cloisters of the south of France in the tenth and eleventh centuries, but with a gayety and freedom entirely in harmony with the festival character of the Exposition; the Government building was in that sort of free Renaissance which the practice of the office of the Supervising Architect of the Treasury Department has made, in a manner, vernacular; it was in fact one of the results of the official organization of architecture, an organization never before attempted in the history of civilized or uncivilized peoples, and one which, after the lesson and the light of the Columbian Exposition, will, we trust, never be repeated to misrepresent our civilization; all that Mr. Atwood, the chief of design in the department of construction, did at Jackson Park was done on a basis of pure academical scholarship; his peristyle and terminal building, in the south part of the park, were of imperial Roman type, while the galleries of Fine Arts in the northern part had their Roman academic character purified and refined by Greek feeling.

Thus only two of the greater official buildings, those devoted to transportation and fisheries, were expressed in romantic terms; all the rest were classic, and, because of the fraternal fellowship of their architects and the intelligent sympathy of the department of construction, produced a result memorable in the history of architecture. Foreign critics have been good enough to say that, according to their own standards, this new-world work was brilliantly done; indeed, that no European work had surpassed it in purity, elegance, and correctness, and none had approached it in scale. But they expressed disappointment that it was not so characteristically American as the civic architecture of our greater cities, especially of Chicago. They expected possibly something new, bold, and astonishing, some expression of semibarbarous power and undisciplined invention, at once admirable and curious; poetic, possibly, but ungrammatical. Under almost any other organization than that which the committee on grounds and buildings of the Chicago directory were inspired to per-

fect, under almost any other director of works and chief of construction than D. H. Burnham, it is quite possible that our foreign friends would have had abundant opportunity to delight in and to criticise the intrepidity and perhaps the unscrupulousness of our own vernacular architecture as it has displayed itself elsewhere in our unguarded moments. But the occasion was such that it was becoming and necessary that we should exhibit our art, not only to the world, but more especially to our own people, in its very best estate, and not in any of its experimental stages. As such it may be asserted with conservative accuracy that it represented the highest civilization yet attained in modern times. The architecture of America, like our language, has its roots in the old world, just as our political institutions are based upon the lessons and experiences of civilization in general. Our architects, like those of modern Europe, have inherited all the knowledge of the past, but their method of using their knowledge is different from that employed by their foreign confreres. Unlike them, they are free from the prejudices created by their own historical monuments, for they have no such monuments. They are in the fortunate position of being able to proceed with the development of old types without being hampered by any patriotic, academic, or other considerations, except such as are needed to keep them in harmony with our material progress in structural and social methods. The old types are as much ours as theirs; they constitute a universal language of form. It would therefore be a work of supererogation to deliberately attempt to force upon our architecture a patriotic expression of spurious originality, to construct a new language, when none was needed, especially in the World's Columbian Exposition, where we wished to welcome mankind with stately ceremony and with a hospitality of utterance which to the people of all civilized nations should be intelligible and polite, and not barbaric or strange.

In using the classic types, therefore, our architects were performing their highest duty to contemporaneous civilization. They were setting before our own people also a visible expression of high culture, which should serve not only as an enlightenment but as an incentive; should open to the minds of the common people of our country, starved by the narrowing experiences of their uneventful daily lives in factories or on farms, in tending machinery or in trade, a wider vision and a far nobler ideal of living. The architectural message at Jackson Park was addressed, not only to the learned few capable of appreciating the technical qualities of a work of art, but to the people, who, while in its presence, far from being indifferent, were evidently inspired with new and higher emotions than ever before had stirred their poor stagnant and darkened lives with the consciousness of new capacities of expansion and knowledge. If this manifestation of cosmopolitan art, illustrated profusely by subsidiary sculpture and painting, created in such minds any of that divine discontent which

is a spur to the accomplishment and maintenance of better and nobler and larger lives, it was indeed an active agent in the service of civilization and was well worth all the labor and study and all the millions which it cost. It has been said that our people took the high pleasure provided for them at the World's Fair too seriously; that they were not gay and laughing as at a festival, but observant and conscientious as in the performance of a duty. They came for pleasure, but after the first emotions at the overwhelming beauty and majesty of the spectacle, they remained to learn. It was indeed a serious business for them and for the future of our country. Art never performed on any other occasion in the world's history a service more memorable or inspiring.

Who among our hard-headed, practical, common-sense people has complained that the cost of the great display was a waste of treasure which might far better have been devoted to some other purpose, as in the founding of a permanent institution of liberal culture? In fact, the Exposition of 1893 at Chicago was itself a free university of the largest possible scope, and its architecture was based upon motives high enough to constitute it a department of the highest learning. Its doors were open to the whole people. No philosopher of the Academy, no scholastic of the Middle Ages, no student of Oxford or Cambridge ever studied in such cloisters or was ever sheltered in porticoes so majestic. If the pleasures which our people took in the shadows of this university had been taken less seriously, perhaps it would have been difficult to condone the vast expenditure.

Preliminary to a critical estimate of the official architecture of the Exposition we have briefly indicated the principal conditions affecting its growth and character. We have also endeavored to show why this architecture was expressed rather in classic than in romantic terms, and how, being so expressed, it touched the popular sympathies and awakened a general interest such as has not been excited by any other demonstration of art at least within the present century. It seems, therefore, worth while in such a report as this to endeavor to trace this beneficent energy in the work of civilization farther back toward its primary causes. There can be no question that the imposing effect of the architectural scheme may be attributed far less to its component parts in the buildings themselves, taken severally, than to their harmonious combination.

To this combination Lake Michigan and its system of waterways within the park furnished the key. The system was itself dictated by the natural topographical conditions of Jackson Park, by its series of low sand dunes parallel with the lake shores, and by the wet, sedgy valleys between, wide spreading and desolate, with occasional growths of oak on the higher parts, stunted by the cold winds sweeping over the icy lake for more than half the year. But it needed the genius of Olmsted, assisted by the quick, artistic sympathy of the lamented

Root, to prepare from material so unpromising for a result so poetic and so noble; to convert those marshy hollows into formal canals and basins in the south part of the park and into a picturesque and winding lagoon in the north; to enlarge and level the sand dunes so as to constitute vast terraces fit to receive the greater buildings, and to bring these buildings into articulate relations one with another and with the waterways, so that there should be nowhere any evidence of accident or caprice, and so that order, "Heaven's first law," should everywhere palpably prevail, as in the avenues and courts of the ideal City of the Blest. So finely organized was the scheme that each of the vast palaces which finally, as with the music of Orpheus, arose upon the terraces of the court of honor thus provided was an essential and indispensable part of it; each responded upon exact center lines to its opposite neighbor. The north front of the agricultural building, with its imperial and lucid beauty, opposed the southern end of the liberal arts building across the great basin and with its west end confronted the east end of the palace of mechanic arts over the south canal, pavilion answering pavilion and portico balancing portico with beautiful variety of detail.

The administration building, the great central monument of the Exposition, was placed at the crossing of the two principal axial lines of the general plan. With its north archway it looked down the long vista between electricity and mines; with its south it opposed the noble central porch of the palace of mechanic arts; with its east it looked across the fore court upon the exact center of the terminal building, and from its east doorway extended the axial line of the great basin, upon which were strung the fairest jewels of the Exposition—the statue of Columbus, by St. Gaudens; the Columbian fountain, by MacMonnies; the gilded Colossus of the Republic, by French, and, finally, the lovely water gate of the peristyle, by Atwood. The long south vista of the great canal was superbly closed by the triumphal arch of the double open screen, which carried the architectural lines of the palace of mechanic arts across the south end of the court of the obelisk to form a brotherly union with those of the palace of agriculture. Thus the court of honor represented and illustrated all that was best in symmetrical composition. It was a symphony not of precise echoes or mathematical repetitions, but of harmonious correspondences, the special and characteristic note of every building playing its due part in the silent music. The justification of this celestial harmony of form was in the indelible impression made by it even upon the dullest and least impressionable minds. The divine function of architecture to elevate, to purify, and refine seemed at last to be restored to mankind.

Every building of the court of honor can furnish many details which might serve as models of academically correct and scholarly technique in schools of design. Doubtless they will be so used for many years.

But it would not be difficult for the critic to take exception to other points, and to wish that they had been somewhat different in certain matters of detail or proportion. But these exceptions are so unimportant and technical, so much a question of personal mood or prejudice, that it would serve no good purpose to dwell upon them in a general report of this sort. In considering the exaltation of sentiment and the high pressure under which these buildings were designed, and the astonishing rapidity with which they were executed, it is surprising that they did not exhibit more oversights of haste and excitement. Indeed, it is a noteworthy fact that several of the more strictly classical designs, as they stand, are absolutely perfect in respect to architectural scholarship. There will hardly occur another occasion in practical everyday life to repeat the magnificent uselessness of the colonnade of the peristyle, of its triumphal arch, of the main porch of agriculture, of the two-storied portico of machinery, of the dome of administration, of the hemicycle of electricity, of the great hall of the terminal building, of the Greek purity of the gallery of fine arts, with its noble entrances and its lovely caryatid porticoes, of the insolent magnificence of the central porches of liberal arts. It is almost a pity that at least these features could not in some way be made permanent as models and standards of execution and design to refresh the minds of our young architects, and to recall them to the contemplation of purer types, when, in the desire to astonish with novelties of bold invention, they are disposed to wander too far astray from the safe paths.

Another principle which these great models have illustrated is the importance of monumental union in all the fine arts. These buildings have shown once more that neither painter nor sculptor is doing his best and noblest work when he is working apart from his natural ally, the architect, who is often in position to furnish the highest opportunities for both. The fine arts need to assist one another and to work in concert. The completion of the architectural project by profuse sculpture, as exhibited especially in administration, in machinery, agriculture, and the peristyle, and in decorative painting, as shown in all these, and notably in the porches of liberal arts and the hemicycle of electricity, is so satisfactory—similar monumental results are so unattainable without this prolific union of the arts—that it would seem that their closer relationship is established for all time, and that we shall see by practice a school of artists arise capable of meeting the most heroic emergencies of decoration.

We have referred to two of the great official buildings as exceptional in that they were based upon romantic rather than classic types. These variations from the prevailing classic theme, as they were the work of architects of exceptional ability and experience, and as they excited much interest and no little admiration, deserve at least a brief consideration. The sites assigned to transportation and

to fisheries were in the picturesque part of the grounds, through which the lagoon was permitted to have it capricious way without restraint. The place invited and excused a sympathetic independence of design. Messrs. Adler & Sullivan therefore evidently felt free to express here a phase of their intelligent process of experiment in adapting Oriental motifs to modern purposes. There was nothing in the practical use of their building—which was to accommodate a comprehensive exhibition of modern and ancient methods of transportation on land and sea—to suggest any definite form, even within the elastic capacities of romantic art, except perhaps that practically the necessity of installing railroad trains in full equipment gave to the plan a large unit of dimensions, which apparently in turn conferred upon the elevations bays of unusual width.

In the exterior design there was abundant evidence of intention to avoid the usual conventional devices of architectural expression, and to apply only severe logical methods. A plain inclosing wall surface with no other incidents than the regular recurrence of large glazed arches; the protection of this shadowless surface by the broad overhang of a flat roof; the emphasis of a very few points by countersunk arabesques; a central porch of receding arches, set in a square Oriental pavilion, flanked by little kiosks, and profusely embellished with diapered ornament like the arcades of the Alhambra. All this could be readily accounted for, and there was little or nothing of caprice to condone. The whole mass was reasonable, but it was not festive, interesting, or poetic, save in its promise. To relieve this seriousness and to confer some definite significance upon the design, statues of railroad people, of great inventors, and two or three allegorical and imaginative groups were added at certain points, not especially connected with the structure. But human figures in sculpture, of modern character, are incongruous with any form of Oriental art, and they did not compose with this. They stood apart from the architecture, and did not aid or complete it. The composition still seemed too severe. The great plain surfaces, therefore, were covered with flat painted decorations in a Byzantine spirit upon a brown-red background, and, in the spandrels, highly conventionalized white-robed figures were emblazoned, with spreading wings. But the regular recurrence of these orderly similar spiritualizations along the immense frontage failed to animate it, but rather added to it a certain religious or ascetic aspect, withdrawing the building still further from its purpose. But the experiment as a whole was bold and interesting. It was worth trying on a scale so monumental and in a place so conspicuous, as an indication to the world that our best men know how to dare without foolhardiness, and that our efforts to develop local style are made upon the broadest and most catholic lines, free from the dictations of schools and the prejudice of fashion.

It was also very fitting that our national studies among the Roman-

esque elements of southern France should have at least one example in Jackson Park, and the experiment ventured by Mr. Cobb in the fisheries building at a point far removed from dangerous competition with any form of classic art, was in every respect successful. It was a picturesque composition of high, red tiled roofs, of clearstories, pointed turrets, and a great central lantern, with grouped windows and light aerial galleries. Its walls were low, and treated, like the monastic arcades of Arles or Fontifroide, with doubled columns, the sculpture suffering a sea change into every form of shell or fish or algæ or marine reptile which could be made to respect the form of a Romanesque capital, to do duty in the enrichment of a Romanesque molding, or to undergo repetition in a Romanesque diaper. These cloistures of ancient form, in which no monk could possibly meditate, were thus made to laugh with a gayety and humor entirely in harmony with the spirit of the place; but the gayety never interfered with the correctness of the chosen type, and the humor never passed the bounds of grace or scholarly conformity. It was a very skillful adaptation of an old theme to modern usage, and the composition deserves also to be remembered with respect, because this alone of all the greater official buildings frankly acknowledged the roof as an essential part of the design, and made no sacrifice of practical convenience to an archæological whim.

If, in the making of the grounds of Jackson Park, and in the location of the palaces of art and industry thereon, there was achieved a result of conformity and mutual adjustment more admirable than one might see even in the gardens of Versailles or of Marly, and on a scale far more colossal, and if the peristyles, kiosks, fountains, bridges, statues, columns, arches of triumph, and other subordinate features distributed among the greater buildings served to lighten the prevailing effect of majesty and order without disturbing it, it must be frankly admitted that a note of confusion and discordance was introduced in a comparatively small area at the northern end of the park by the emulation of the States of the Union in their pavilions. The parklike aspect formerly presented in this part of the grounds by the lawns, driveways, and fairly grown trees quite disappeared, and its avenues, crowded with the ambitious and incongruous structures of the rival Commonwealths took upon themselves the heterogeneous characteristics of boulevards in a prosperous town. Several of these structures were beautifully designed, and were contrived, with great success, to recall the historic memories of the States, respectively, which erected them. But no attempt at harmony was made. Many of them were too large for their purposes, and all were crowded far too closely for any dignity of effect. Each one, instead of being isolated in its own pleasance, surrounded by trees and shrubbery, where its reminiscences of English colonial dignity or of the Spanish missions or of any local quality of Eastern or Western civilization

might be independently expressed without challenging comparisons, elbowed a neighbor "in contact inconvenient" on either side. Some of them, indeed, were frank examples of our own outworn vernacular architecture, with all its offensive and ungoverned crudities of detail. Perhaps it was well that this element should be expressed somewhere at the World's Fair, for the sake of local color, and that in comparing these huddled incongruities with the ordered grandeur and beauty of the main part of the Exposition grounds, the spectator might find the best sort of admonition as to the supreme value of art, not only in designing buildings, but in designing combinations of buildings in towns, squares, and streets, so that every structure in them should have some relation of harmony with its neighbors.

The architecture in the northern part of Jackson Park was developed under conditions entirely different from those which controlled that of the great official structures of the Exposition elsewhere in the grounds. The latter, as we have seen, enjoyed in a manner and to an extent quite unprecedented in the history of the art all the advantages of a fraternal cooperation of architects, sculptors, and painters working under the inspiration of enthusiastic zeal to accomplish a great, complicated, and harmonious work of art in the best manner which our scholarship and genius could command, and within a few short months of feverish and anxious activity. This cooperation was made possible and effective by an official organizing power, closely sympathetic with the highest objects to be obtained and powerful enough to command respect. But the buildings representing foreign nations and our own States were designed without knowing any common standard of excellence by which they were to be measured, and without recognizing any common type by which they were to be brought into some relation of harmony. Each was designed independently, and no architect knew how his work was to be affected by that of his neighbors. Indeed, most of these architects were selected by the several State commissions, in the absence of special knowledge or convictions or interest, under the usual conditions of chance or guess, of policy or expediency, of prejudice or convenience, or personal affiliation—in fact, under any conditions except those of tried and acknowledged ability for the required service. It is remarkable that from the accidental average of professional knowledge, made available to the commissions in this way, so much creditable work should have proceeded. But the individuality of expression in each of the State buildings resulting from this independent method of work, though absolutely destructive of those great and memorable architectural effects which can only be obtained by an ordered cooperation of exceptional talent, was not without interest.

The older Commonwealths of the Union, with scarcely an exception, in their representative buildings, seemed anxious to make the most of their brief historical past, and the old colonial style, with its decent clas-

sic precision and its prim formality, appeared in the structures erected by Massachusetts, Pennsylvania, Virginia, Maryland, Delaware, New Jersey, and Connecticut, some of these States practically reproducing monuments connected with important persons or events in their several histories, and their relative rank in the competition of architecture has to be decided by the application rather of an archæological than of a purely artistic test. New York, however, proudly declared its cosmopolitan greatness and its larger relations with the outside world, not by reproducing one of its own Dutch manor houses, but by an elegant Italian villa, such as might have been built in the best era of some prince of the church, recalling especially some features of the Villa Medici. Like everything else done by McKim, Mead & White upon these grounds, it was, within and without, rich and aristocratic, as carefully designed and executed as if it had been intended as a permanent monument. Louisiana gave us, significantly, a planter's house, with a colonnade or "gallery" in the Greek Renaissance of the early part of the century, so peculiar to the old estates of the Southwest. Colorado expressed itself properly with a picturesque and carefully studied design in the old Spanish manner. California combined, on a vast scale, the most characteristic features of the adobe Spanish mission houses, and produced perhaps the most striking and poetic example of romantic art in the Exposition.

Florida was too frankly archæological in a reduced copy of old Fort Marion at St. Augustine. The States of Washington and Idaho very cleverly illustrated their great timber industries, the former by raising a half-timbered building upon a stylobate of huge unhewn logs; the latter by a Swiss country house of log-cabin construction, an ingenious type of honest and vigorous design in primitive architecture. But it was evident that the architects representing most of the newer States of the West, as yet without a history, found it difficult to give characteristic expression to their buildings, and whenever these fresh and vigorous Commonwealths, like Minnesota and Missouri, Arkansas, Indiana, and Iowa, preferred to repeat in their buildings reminiscences of the fatigued architecture of older races, more especially where their choice fell upon styles rich, but without strength or purity, developments from the spirit of luxurious and self-indulgent courts, there was an incongruity which was perplexing to the critic, if not absolutely grotesque. Even rural Vermont, of the older States, could find nothing more appropriate to her condition than a delicate little Pompeian villa, interesting in itself as a study, but without a hint of characteristic expression. Rhode Island, Ohio, Nebraska, Dakota, and Michigan were noncommittal, but respectable, in a dress of English classic renaissance, to be judged rather by their conformity to a scholastic type than by their success in representing local conditions in terms of art. But Maine and Wisconsin presented characteristic vernacular compositions which could only have ema-

nated from an American State and which fairly set forth our native versions of Old World types.

Illinois also, standing on her own ground, and eagerly welcoming with imperial hospitality the nations of the world to her festival, attempted in the architecture of her official residence, to express neither her products, her history, nor the especial quality of her civilization, but preferred unfortunately to pose in a masquerade of negative architecture significant of nothing in the well-defined genius of this progressive Commonwealth. She erected upon a conspicuous site the largest of the State buildings; her architecture followed general Renaissance lines, but without intelligent loyalty to any established type; its decorations were profuse, but without character or vigor or local suggestion, and they were distributed without subordination to any articulate structural scheme. It culminated in a very lofty dome somewhat similar in outline to that of some Mohammedan mosque, but with pseudo-classic detail, applied apparently rather with the intention of being original than with the purpose of securing grace of contour, harmony of proportion, or correctness of grammatical or rhetorical expression. It would hardly be necessary to dwell upon this unfortunate feature, if, in almost every general aspect and vista of the Exposition, it did not challenge criticism. No example could more clearly illustrate to architects the danger of indulgence in capricious invention and personal or temporary moods.

There were more than thirty of these State buildings on the Exposition grounds, and on the whole, by their contrasts of character, they constituted a curious proof, if any were needed, of the capacity of architecture to express an infinite variety of ideas and conditions. This division of interest on the avenues of the States was amusing and, in its way, instructive. To the foreign judges especially it furnished a rather impressive object lesson of the keen but friendly emulation existing among this great group of Commonwealths, of their large hospitality, their local pride, and the infinite variety of their natural and acquired resources. If it had been possible to base these numerous architectural expressions upon some unvarying formula, at least of dimension and scale, the contrasts would have been not less instructive and much more delicately marked, and the total effect would have been far less distracting to the judgment. The great architectural lesson of the Fair, illustrated emphatically on the court of honor, was that unity gives peace, repose, and majesty, and that mutual independence implies contention, unrest, and loss of power. There was every artistic and poetical reason why this idea should have been even more fully illustrated at Jackson Park by expressing the political union of the States in a corresponding union of architectural principles. The motto of our great seal—E Pluribus Unum—would have been particularly happy in its application to the designing of these representative pavilions.

But no such bond, no such corde sensible, could exist among the foreign governments who were represented at the Columbian Exposition with such splendid liberality. The architectural exponents of the friendly nations, thus brought together in this great emulation of peace and good will, were naturally and fundamentally in a state of artistic opposition or contrast, not forced, studied, and artificial, like those of our own commonwealths, but developed through slow centuries with the growth of the various races of the human family. The roots of these divergencies of types were in the remote past; they were inevitable and contained the essence of history. Each of these foreign pavilions asserted its individuality without affectation; each spoke its own natural language with fluency and without consciousness of quotation. Germany, in all her demonstrations and installations in every department of the International Fair, expressed her wealth, her power, her history, and her abundant industrial resources with lavish generosity. She accepted our invitation to be present with a hearty good will, which was more than perfunctory, and which, notwithstanding her warlike armaments, will be remembered as an earnest of universal peace. Her official building was mainly in the form of a mediæval townhall of considerable extent, picturesque, romantic, and entirely Teutonic, with tiled roofs, half-timbered gables, a loggia looking toward the lake, and a tall, slender, bell tower, designed with a fine spirit of aspiration. Upon the exterior were emblazoned in colors brave flourishes of conventional foliage, hung with armorial bearings, exploding, as it were, with flowers, and enveloping figures of gallant men-at-arms with pomp of waving crests and banners of strange device; the whole a genuine architectural expression of old historical Germany, surrounded by a mist of old-world legend and poetry, wonderful to see in the frank, lucid atmosphere of Chicago. England stood aloof by the lakeside in a many-gabled Tudor mansion in comfortable assured possession, claiming, as it were, her ancestral rights to a perfect domesticity without any nonsense of romance or ostentation, not at all jubilant, but reserved and eminently respectable. Spain near by, behind a façade of old Valentia, decorated soberly with fine cuspidated tracery in the old Iberian manner about her doorway, with merlon and battlement for her skylines, dwelt with undisturbed gravity, conscious that her own Columbus gave her a peculiar right to the hospitality of the new world.

Sweden, upon an exceedingly clever plan, developed a complicated composition of strange gabled pavilions, connected by peculiar glazed galleries and buttressing joyously a climbing central tower of bulbous roofs, with a lofty culmination of vane and finial, bearing to the sky the crown of the Scandinavian kingdom—a strange but harmonious outline; but the strangeness of it was carried with an easy native grace; with none of the self-consciousness of a masquerade in bor-

rowed plumes. This demonstration was also most evidently genuine, and so was that of her sister, Norway, who repeated on these astonished grounds one of her own timbered mountain chapels, decorated with Celtic braids and convolutions, with a complication of heavy gables, upward curved at the lower angles, and with ridges shaped at the ends like the rearing dragon-prows of her viking ships. France, accustomed to take the high place in all the fields of art, here expressed herself in two stately pavilions in her own Renaissance, with buttresses of detached columns, and with attics too heavy and massive for the substructure; between these pavilions she planted a garden with a fountain in the midst, and inclosed it in the rear with an open loggia, hung with pictures of the greatest monuments of France, and forming an ambulatory sweeping with a hollow curve from wing to wing. The composition, though on the whole disjointed and disappointing, was distinctly festive in character and its academical detail kept it easily in the first rank of art, where France is always at home. Turkey reproduced the fountain of the Sultan Ahmed III in a pavilion whose widespreading flat roof, with carved eaves, overhung walls incased with square panels of dark wood, sculptured curiously, and inlaid with devices of ivory and mother-of-pearl. The door, exquisitely fretted with open arabesques and with texts from the Koran, stood wide to welcome the infidel hosts of America.

India dwelt in a fair kiosque with a portico of pointed and fretted arches and a roof supported on complicated brackets; in color and form she presented us with an exact and perfect epitome of her sumptuous arts. Rugs with all the splendid profusion of the East were piled in her portico, and within the air was laden with the perfume of sandal wood and cassia. Ceylon also gave us a glimpse of another phase of Oriental art, no less characteristic and no less profuse. The ardent temperament of the southern races of America, nearly all present at this peaceful union of the nations, adapts itself lightly to expressions of festivity, but without any attempt at purity of style. Guatemala, Costa Rico, Nicaragua, Venezuela, and Colombia vied one with another in gay pavilions, each expressed in a local dialect of the loose Renaissance of their great Spanish mother; careless and ungrammatical, but not without the charm of an unaffected accent. Guatemala's pavilion inclosed a characteristic cortile, surrounded by a gallery, with fountains and tropic luxuriance of great leaves and bright flowers. But Brazil was ambitious in a monumental casino, built on the plan of a Greek cross, with towers in the internal angles and a central culmination of dome and lantern, all expressed in a florid but clumsy and semibarbarous classic, making sad havoc of the Renaissance of France. Finally remote Japan retired among the trees of the wooden island and there constructed two temples, recalling by fine contrasts of character, unappreciated by the western mind, two phases of her own history far apart. These are connected by

a wooden colonnade. The general architectural scheme has been so often graphically set forth for us by her own artists that this materialization has hardly any surprise for us. Its heavy tiled roofs, thick as the eaves and turned up tent-fashion at the corners, its curiously carved and complicated ridge poles, the lacquered screen work of its panelled walls, the unaffected purity and simplicity of the interiors, the subtlety of the scheme of color, the delicate reserve with which it displays the perfection of its inlaid bronzes and pottery, the strangeness of the carpentry—all this is grave, sweet, and dignified, inspiring respect for a race which, in the presence of the sophistications of Europe, knows how to preserve the integrity of its ancient traditions of art.

The limits of this report forbid us to attempt anything like an exhaustive statement of the architectural conditions involved in the almost innumerable kiosques, and pavilions for special exhibits, in the columns, fountains, and monuments, in the bridges and landing places, and their decoration and completion by groups of statuary, illustrative of our most characteristic wild and domestic animals, and of our conditions of agricultural, pastoral and frontier life. Nor can we more than refer briefly to the mediæval villages and towns, to the Moorish and Venetian palaces, the streets of old Vienna and Cairo, the bazars of China, Algiers, and Tunis, the temples of Egypt. These reproductions can hardly be judged as architure; they are rather picturesque, and, perhaps, more or less theatrical, but sufficiently correct and realistic to do their part with the more serious monuments of the exposition, in the work of creating, through manifestations of art in all its forms, those higher and nobler ideals of life, that larger vision which are necessary to the full fruition of the new civilization of the West.

ART EMBROIDERIES IN THE WOMAN'S BUILDING.

BY

Mrs. F. G. STEBBINS, Judge.

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The art of embroidery was practiced at a very early period, as we find from mention made of it by sacred writers. The earliest notices we have of this art are found in Exodus xxiv, 36, and xxxix, 6, where instructions are given to the Hebrews for embroidering the curtains for the tabernacle with such magnificence that we have reason to suppose their knowledge of the art was very great and was acquired in Egypt. Homer makes constant allusion to embroidery. In Greece the art was held in the greatest honor, and its invention ascribed to Minerva. From that time on through ages until the present embroidery has held its sway untrammeled.

From the great and marvelous display gathered here from nearly every nation and country of the globe, we get a minute idea of what creations have been wrought by the patient and æsthetic fingers of all ranks, from the palace to the cloister. The noble and ignoble, all have taken a hand in this picture needlework.

MEXICO.

Embroidery must be an universal accomplishment among the Mexican ladies, judging by the quantity and variety displayed in the manufacturers' and woman's building. Flowers seem to be a favorite design, and are cunningly wrought with silk, linen and cotton, wool and gold thread. The needlework is a marvel of artistic ability, patience, and tenacity of purpose. It is delicately designed and exquisitely executed, having web-like airness that makes it seem like spider industry.

There are many pieces of photographic embroidery. The work is done with ravelings of silk velvet; very delicate and short threads are used on a white silk background. The stitches are so fine it is impossible to discern them with the eye without raising them from the surface with a pin, and wonder deepens into amazement when you look for stitches on the wrong side and find none. Close examination defines that these stitches are inserted between the two surfaces, the warp and the woof. It seems as if the embroiderers must have been endowed with a magician's skill.

The shading in these needle photo pictures is as fine and artistic as that seen in steel engravings. Among these pieces are portraits of President Diaz and Benito Jaurez. The two specimens noted are the

work of Ester Teran. It takes from four to six months to embroider one of these portraits. A large picture, a facsimile of the World's Fair building, would be mistaken by an expert for a fine etching, done in this same style of work and executed by Teresa Gonzalas under the tuition of Mme. Figneroa Esperion, the most skillful embroiderer in all Mexico. She is connected with the art schools of the City of Mexico, and has received eight gold medals at Paris. This picture is valued at $500.

The schools of art of Yucatan, Toluca, Monterey, and Guadalajara are also here represented, all showing work as from fairy fingers. There are chairs with seats and backs elaborately wrought with genuine gold thread made in a peculiar manner by hand. The gold is twisted on a thread of pineapple fiber so smoothly as to be easily threaded into a needle. Embroidered huipils (dresses) made of material woven on primitive handlooms by native Indians, of which there are sixty different tribes scattered among the different States.

Church vestments of regal magnificence are here in glass cases. Some are centuries old and are reproductions of Aztec designs. The more modern are the conventional designs used by the Church and are almost priceless in value. One is an altar cloth, the foundation being silver net made by hand and is embroidered with pure gold thread. Another represents the Madonna and Child, embroidered on a solid silver background with pure gold thread and silk, is very old, valued at $1,000. A wonderful specimen of ancient picture needlework wrought in silks represents a priest standing over the dead bodies of an Indian and maiden on the threshold of a monastery where they had gone for protection. This Spanish priest, Bartolome de las Casas, came to Mexico when Cortez ruled. He was a protector of the Indians against the cruelty of Spaniards who killed them by the thousand. During the epoch in which this occurred, Spaniards stood in great awe of the pontifical authority. This picture is a copy of a very large oil painting found in the Academy of Fine Arts of Mexico. A monument in the City of Mexico also bears the name of this priest, Bartolome de las Casas. The exhibit is under the direct supervision of Señor Ricarde de Mariad y Campos—a gentleman who has the fullest confidence and friendship of President Diaz. It is to his skill, patience, and courtesy that this beautiful exhibit owes its undisputed success. When the judges came to make an examination, after an appointment, each exhibit was ready with the assignment card attached which facilitated the work greatly. Mexico can boast of 280 medals awarded in this department of art needlework.

SIAM.

Only a step and turn from Mexico and you are brought into recognition of the cozy little pavilion of Siam. Here one beholds a wonderful display of embroidery in gold, silk, and silver, including

among them folding cushions—some square and others round—and pillows covered with embroidery resembling flowers and foliage, cut from one solid sheet of burnished gold. Not a stitch can be defined, and yet it is an art of stitchery adroitly executed, which device is known only to the Siamese women who are remarkable needleworkers and embroiderers of exceptional merit. These cushions and pillows are unexcelled in durability, richness, and usefulness. A cap of the young prince of Siam composed wholly of real gold embroidery, which is unsurpassed in workmanship and beauty, receives general admiration. There are also plants reproduced in silk, silver, and gold, which produce a most pleasing and charming effect.

In this little pavilion are also seen a collection of richly embroidered screens; gold and silver entering largely into all these pieces of work. Large pieces of fine-art embroideries and rich tapestries, illustrating native military subjects, and combats on elephants between the Burmese and Siamese. These are remarkable for their beautiful coloring and high artistic finish, especially noticeable in the execution of animals and the costumes of the various warriors.

A needle picture embroidered in gold and silk, representing a royal barge containing the royal family who are out on a pleasure trip, is fine, and true to life. In the central section of the building are exhibited, in large glass cases, the full state robes of a Siamese prince, woven with real gold and silver thread, also a girdle that is usually worn with it, and which is studded with genuine sapphires and rubies. There are embroidered slippers, robes of noblemen, remarkable for the richness of the gold embroidery. The gold lace shawl worn by the Queen of Siam is a superior work of art, and is bordered with gold fringe of great value.

The exhibit also comprises the costumes of Siamese princes worn at Soken ceremonies, all of which are decorated with rubies, emeralds, and other precious stones. Part of a prince's full state costume is composed of arahams, a magnificent apron ornamented with real gold lace. In addition to this costume, the one worn by His Majesty the King during the ceremony of entering the priesthood is in part also shown, the gold cap and lace veil being especially remarkable. The women of Siam are expert and untiring in needlework. They toil from sunrise to sunset. They are represented here at the World's Fair by Mrs. Phra Suryia, maid of honor to the Queen, who has entire charge of this valuable display of the work of Siamese women, having spared no time, trouble, nor expense in making the exhibit one of the most interesting in the exhibition. And it is well worthy of this far-off country, whose twelve millions of souls are now thirsting for progress, advanced civilization, and peace. The awards granted them are as well deserved as they are numerous; their embroideries being not only of unsurpassed excellence, but also peculiar to their own country.

FRANCE.

One of the most interesting spots in the woman's building was the Parisian drawing room in the southwest corner of the building.

Undoubtedly the richest pieces of embroidery exhibited in this salón are those executed by the well-known Parisian artist, Mme. Lerondier, her wonderful reproductions of Audran's "Months," upon which she was engaged twelve years. They are twelve in number, one for each month. They are as remarkable for their delicacy and beauty of execution as for the elegance of the design, the exactness of style, and the richness of color.

The panels, about 3½ yards high by a half yard broad, are like pictures in silk. It is difficult to believe that it was possible for one woman to accomplish so much work. As a rule, in work of this nature an artist has a full-sized painted model before her, so that the task becomes one of copying in silk instead of with the brush and oil. Not so, however, in the case of the panels which the author worked from, but a small-sized black engraving of but a few inches square. The designs were originally made in the seventeenth century for the royal manufactory of the Gobelins by the celebrated Lyonnese engraver, Audran.

Fifteen years ago Mme. Lerondier came across an old set of the engravings. They made a deep impression on her artistic sense, and without hesitation she set about the accomplishment of what is by far the most extraordinary undertaking ever attempted by a single person in artistic embroidery. She had to invent her own coloring and shading. No one assisted in giving indications as to proportion, and when once she had completed all her designing it was necessary for her to retain the service of a dyer willing to work according to her directions. All this she did without despairing of the final results.

Without close inspection, these embroideries are mistaken for paintings in oil. These panels grace each side of the magnificent Aubusson tapestry, called "Toilet of Psyche," copied from a painting in the Louvre, full of poetic beauty and grace. The figures are wonderfully expressive, rose tints innumerable give this a warm and most charming effect. So little of this tapestry can be done in one day that years must have been necessary to complete it. The high value is not alone in the time requisite, but also and chiefly in the fact that it required the practiced eye of an artist, as well as almost superhuman patience, to execute these faithful reproductions in wool and silks of the paintings of celebrated artists. At the left of these magnificent panels are lambrequins in bullion embroidery, and silk curtains worked with chenille, exact reproductions of those executed for President Carnot by Mlle. Bertha Floury; and in tall glass cases were dress front, embroidered exquisitely, while a basket of roses looped over a Louis XVI scroll challenge the admiration of everyone as being a

masterpiece of art ribbon embroidery. Here is an artistic panel screen framed in dark rose velvet "petit point," the design being in the decoration of Louis XVI, copied from Boucher. The figures are so delicately shaded that it almost requires a magnifying glass to decide that they are not painted.

Graceful garlands and bouquets cover a pale rose-colored field and seem to be in relief over shadowy leaves designed in the groundwork. The screen is about 3 by 5 feet, and has over 1,000,000 stitches in it. The coloring is very fine and unobtrusive and one appreciates its value immediately. It is the largest piece of Gobelin point made in France during this century.

Vaugeois and Benot exhibit the "Trophy Renaissance—Armor of the XVI Century" embroidered in pure gold thread in raised work, shown in relief on a crimson plush shield. A collection of antique altar cloths and hangings, vestments, and pieces for decoration, Venetian embroideries, spangled applique work, fans, screens, and portfolios, all contribute of their rare beauty to make up this unsurpassed exhibit, which no pen can paint nor language adequately describe.

France has again shown her preeminence. Her people, confirming the general judgment on this point—so supremely artistic—have much to teach us. Their work shows greater knowledge of the relative value of color and a better sense of harmony in arrangement, for the reason that it has been brought under the dominion of law. Hence all their productions are beautiful, harmonious, and rythmically complete. Generations of art culture have told upon a people of rare artistic endowments as they have not yet told upon us, for we have not yet had time to learn.

The art of France reaches back to the time of Colbert, in the seventeenth century. After the decay of art in Greece, Italy took up the scepter. And when Italy in turn surrendered it into the keeping of France, it was only a following of the inevitable "Western Course of Empire." It may be for the future to show that, with our mixture of races, we are wanting in some of the elements requisite to preeminence, but on the other hand, it is not beyond the possibility of belief that in this great fact of mixture may lie our strength that another century may find an artistic supremacy also on this side of the sea. Already America has made her mark in many departments of art, as the Old World cheerfully conceded. Let us see what new proof she has made of her powers.

THE UNITED STATES.

As it is impossible to speak of all the beautiful work exhibited here by associations and individuals, I shall attempt only that showing the greatest advancement and excellence.

Let us commence with the New York Decorative Art Society, the parent organization from which so many schools have sprung. Among

the most interesting objects in its collection are three: A beautiful bedspread embroidered in gold and silk thread, on a heavy white silk sheeting, in various and intricate German stitches; another spread in Portuguese design, laid work on changeable silk, executed in various brilliant colors; a wall-hanging design "Italian Barocque," and cushions beautiful and luxurious, in Spanish and Egyptian chain stitch. All these, with specimens of tea cloths, doilies, frames, scissor cases, table covers, and center pieces, form a fascinating study.

Miss Mattie Gibson, of New York City, has a table spread of white linen damask, embroidered in pale yellow and green silks, showing artistic skill and merit. Mrs. Theophila F. Kraemer, of New York, shows a wonderful conception in needle painting in the form of a female figure, with cloud effects. The perfect curve and manipulating of stitches are admirable.

Dainty and effective embroidery of the Boston Society of Decorative Art is a delight. Foremost among its exhibits rank a set of doilies for dessert plates. The designs are in the Marie Antoinette style, and are executed on fine white linen lawn. The embroidery is worked solidly in varied coloring, characteristic of these little French designs.

No two doilies in the whole number are alike, various emblems and devices being used, but the same general idea in arrangment is maintained throughout. Another dozen doilies, the work of Miss Little, a member of the society, is marvelous for their exquisite daintiness. The designs are minute birds on swinging féstoons of roses and buds and leaves, so very small, delicate, and perfect that one is astonished at such proficiency with the needle.

Boxes and frames made of different shades of velvet and vellum, embroidered in silk and gold spangles are also beautiful. Great artistic talent, united with a practical knowledge of the possibilities of embroidery, are characteristic of this society.

Miss E. F. Fluke, of Kittanning, Pa., deserves particular mention for the execution of two round centerpieces of white linen lawn, embroidered; one in design a wreath of orchids in delicate shades of pink and green, the other a most exquisite design of pale pink double roses, representing a picture in water colors, delicately toned. It is a dream of loveliness.

Mrs. Bresleau, of Washington, D. C., contributes a large white linen tablecloth embroidered in silks; the design, a border of pale pink orchids, is perfectly shaded and fine in execution. It was bought by a foreign nobleman, as he considered it one of the gems of American embroidery.

The Philadelphia School of Art Needlework consists of 23 pieces, all of original designs. Among the most prominent is a screen in three panels, to wit, sage-green satin, embroidered in colors—a Louis XVI design; a purple cloth pall with wide border of white cloth appliqué

work, and a center of large palm leaves embroidered in green crewels; a bedspread of white linen embroidered in very delicate blues, English in style; and an exquisite fan of white gauze, on which white blossoms and leaves were wrought. A centerpiece of white linen embroidered in silks after a mignonette design is unusually fine needlework, nothing lacking—nothing in reality but the fragrance.

The same society presented a fine white linen bedspread embroidered in pansies in silks in natural colors of blossoms, that was an admirable piece of shading and execution; also a portiere of cream-white silk sheeting, bordered with dull green plush, with pink roses and lattice work of Rococo design, worked with silk and gold thread, and finally an altar cloth of white silk with conventional design in colors, a fine example of the church work for which this school is famous.

The Baltimore Decorative Art School must receive honorable mention for its original and artistic designs and superior execution in art embroidery.

The St. Louis School of Art Needlework gives proof of great advancement in its fine exhibit.

Miss Lillian A. B. Wilson, of Meriden, Conn., has a collection of fine embroideries, delicate and perfect in shading, correct in design and execution.

Mrs. Mary Williamson, of Indianapolis, Ind., has an exceedingly interesting exhibit.

The needlework display of Marshall Field, of Chicago, Ill., was a great attraction.

The exhibit of Associated Artists of New York City was a notable one, not only as the result of women's efforts, but upon the ground of great perfection of quality and beauty, and as an advance in art manufactures that should be regarded as of importance to the world of applied art. Nothing in the whole history of the art of weaving could be more beautiful than the gold and silver and silk brocades produced by these artists. Designs, color, and texture are equally considered in their productions. It is evident that not only has artistic knowledge been brought to bear upon them—knowledge of design as applied to textiles, and of the laws of color and effects producible by its use—but effective study of oriental and antique fabrics as well.

Certainly such softness and richness of substance, such creamy smoothness of texture, such union of flexibility and firmness of body, could only come of careful study of the possibilities of silken threads. The same and more may be said of the "needlework tapestries" or embroidered wall hangings belonging to the same exhibit. The subjects of these tapestries are life-size figures, ideal or historic, drawn by women artists whose reputations have been made in graphic and pictorial art and who have successfully applied their talents to decorations. Among the tapestries are some from cartoons by Rosina Emmet Sherwood, Dora Wheeler Keith, and Amanda Brewster Sewell.

One of the tapestries, an ideal conception called "The Birth of Psyche," represents a winged female figure rising up in a dreamily ascending line, like curling smoke, through the rosy mists of morning, her garments still trailing along the earth, her gossamer wings expanding in the mild air of the newborn day. Painting, whether in oil or water color, seems incapable of adequately rendering these delicate atmospheric effects, but in this creation of loom and needle both nature and imagination seem to have found expression. Of these tapestries Mr. Koeher, the eminent art critic, says, "In the field of art needlework these tapestries mark an epoch." The embroideries of this collection partake of the same excellencies, their peculiar distinction being that they have not only benefited by an evident study of the best works of the best epochs, but the conjunction of weaving and embroidering practiced by this band of artists has made it possible to weave grounds which are in themselves no small part of the beauty of the whole.

Thus in the hanging called "The Fighting Dragons," the color of which is a wonderful mingling of metallic hues, vigorous animal action is expressed in an almost startling manner. The ground against which these scaly-winged, glistening creatures are writhing is a mixture of deepest indigo, shot with gold thread, a fabric evidently woven for the subject and as full of beauty and mystery as a midsummer night.

Again, there is a sheet of delicately colored drapery which is called "Dawn," where all the rosy and golden and azure tints of early morning, shimmering together over the surface of the silk, broken only by forms like the rayed star clematis darned in, in varying silks slightly stronger in tone than the color of the ground, the whole producing a web of color which is like the dawn—like an opal—like a dream of some celestial garden.

It is such efforts as these in which imagination, skill, and unusual opportunity unite that make the high-water mark of the arts of weaving and embroidery and give the examples which lead up the general level to a plane of excellence.

It is pleasant to know that every specimen in this collection received a medal, so well deserved.

American embroideries have, first of all, purely American characteristics in design, with extraordinary beauty of color, and secondly, unusual artistic treatment.

The growth of American art needlework in this respect has been unparalled, since our development dates from the Centennial Exhibition of 1876.

The whole exhibit of American art needlework was a great delight, and certainly a source of pride as a national accomplishment.

MODERN BREAD-MAKING MACHINERY AND OVENS.

BY

P. J. McMAHON, Judge.

MODERN BREAD-MAKING MACHINERY AND OVENS.

By P. J. McMahon, *Judge*.

Though bread is a general article of diet in almost universal use among civilized nations, its manufacture has, until recent years, received but little attention from mechanical inventors. Mechanical skill had revolutionized the manufacture of the flour from which the bread was made; the wheat was cut and thrashed by automatic machinery, and magnificent automatic mills, with economy and perfection of work make flour better and cheaper than ever before. But when the flour came to the bread maker, there the chain of mechanical invention was broken. A wooden trough, a table, possibly a hand sieve, a few tin molds, and an open furnace oven, completed the outfit of the bakery, presenting little or no improvement over what is known to have existed in primitive and uncivilized times.

It might be interesting to inquire into the causes which thus delayed the baking industry and so long degraded it below many another of much less importance. How bread making was emancipated from the kitchen would form a curious chapter and, indeed, requires to be explained before we can fully understand how bread making became an industry.

It would appear that Europe had made greater strides than the United States. But even there, until a few years before the Health Exhibition in London, 1884, practically nothing existed but a few crude machines, and attempts to improve on bread-making methods. From the date of that exhibition, in which a number of engineering firms came forward as specialists in that class of machinery, increased attention has been given to the mechanical needs of the baking industry.

In the initiation of improvements many flour-milling firms took part. Small bakeries, without capital and with uncertain trade, made poor debtors, and though many millers contented themselves with "tying up" or leasing bakeries, the more progressive undertook the business of bread making themselves, and thus became their own creditors. With larger capital they were able to introduce improvements and the result was eminently satisfactory. Men who in their mills had the most perfect modern appliances would insist upon fitting up their bakeries in a similar manner, expecting equal economy and an improved product.

Well-to-do bakers accompanied this reform and eventually independent capital stepped in and completed the revolution. They have now bakeries mounted on a large scale involving millions of dollars of capital. The last twenty years have practically witnessed the whole of this evolution. And though it can not be said to be perfected, it may be said to rank now by the side of other and older industries, and to be accompanying them in the march of improvement.

From the very first there was an attempt made to introduce chemical raising of dough, either by the direct mixture of chemicals, or by the injection of gases. The bread thus made has never enjoyed any prolonged popularity, and has been condemned by the best scientific opinion. It has been proved to be inferior to yeast-raised bread in flavor and digestibility.

Had the preference been given to chemically raised dough our system of bread machinery and ovens would have been considerably altered. Indeed, it is claimed at the present day, that there is but one class or make of kneaders that treat dough other than as a chemical and inorganic product. It is claimed that until the introduction of the Differencial Kneader of Messrs. J. Baker & Sons., of London, and of their latest "Patent Baker Kneader" (of 1892), all machines have had but the one object of mixing, and in many cases are claimed by their makers to be equally adapted to mixing of powders, putty, paints, and similar products. Now Messrs. Baker & Sons claim to have had from the first realized the essentially organic qualities of yeast, and have striven so to treat the dough as to preserve the yeast germs in full vitality.

In their latest type machine, "The Baker," seems to be embodied the best results of their long study and experience. Two sets of mixing arms arranged in pairs on opposite sides of the semi-cylindrical drum of the machine, operate in two different ways, and at two different speeds, according as required by the stage or quality of the dough. For instance, when the water, flour, and dough are first introduced, one movement of the mixing arms serves to rapidly incorporate the whole into a dough of even texture, while the next movement (set in motion by a special lever for that purpose) laps this dough in folds over upon itself in a gentle manner, bringing out the strength and elasticity of the gluten in the flour, and surrounding the yeast germs with a layer of air which provides the oxygen so necessary to their healthy growth. At no point is the dough unduly cut or rent, or subjected to a rubbing or grinding action or to heavy pressue while being kneaded. This rational treatment of dough as instinct with organic life, is what distinguishes the "Baker" kneader above others. The qualities of the dough manufactnred by this machine are unsurpassed by the best and most carefully prepared hand-made dough.

In the matter of ovens there is also great diversity. Other manufacturers of various countries making a specialty of this class of ap-

paratus have made and advocated various types of hot-air, hot-water, and steam ovens all with the object of securing a cleanliness, economy, and regularity not obtainable in the old-type open-furnace ovens. But following the same careful attention which they had given to the organic character of yeast, Messrs. Baker & Sons have studied the effects of different kinds of heat, and have been brought to recognize the active chemical properties of heat directly radiated from the points of combustion. Just as the vitalizing energy of direct sunlight has been recognized, so an analogous energy exists in nascent heat, and is quite distinct from the nominal temperature, and has an unmistakable chemical action on bread brought under its direct action. The peculiar sweet, short, and digestible crust of bread baked in the old open-furnace ovens has never been attained in any hot-air, hot-water, or steam oven yet constructed.

It is in combining the direct vitalizing heat of the old style oven with the cleanliness, continuous baking, economy, regularity, and general adaptability claimed for other patent ovens, that Messrs. Baker & Sons have achieved marked success. Their "Bailey Baker" patent continuous-baking oven was introduced only in 1884, at the London Health Exhibition; but gained the highest medals awarded, and has since then, been erected in large numbers, and has been a prominent factor in revolutionizing baking in many countries.

Next in importance, after the mixing of the dough and the baking of the bread, comes the blending, sifting, and weighing of the flour, the tempering and measuring of the water, and the dividing of the dough into equal parts and correct weights. To each of these departments have Messrs. Baker & Sons given special attention, as evidenced by their exhibit at the World's Columbian Exposition; and their different machinery and appliances for attaining the desired results are sometimes most ingenious and unique.

Their hydraulic dough, dividing machine, which in a few minutes will deliver 1,000 1-pound loaves accurately weighed, is instantaneously adjustable to different weights, and manipulates equally all qualities of dough.

The arrangment for flour-blending, sifting, and weighing are substantially what are to be found in large flour mills, with, of course, provision for the special conditions of a bakery. The accurate tempering and measuring of the water is also a distinct advance over the thumb and rule method generally in vogue, and will be understood as a necessary guaranty against errors by employees and as essential to maintaining a standard quality of bread. The special apparatus for determining the bread-making qualities of different flours and blends; the special apparatus for determining and regulating the proper temperature of sponges, the different apparatus for straining and cooling potato ferments and breaking in sponges all go to the making up of a complete modern bakery.

Of the different exhibitors of machinery at the World's Columbian Exposition, for making bread and other bakery products, Joseph Baker & Sons, of London; Werner & Pfleiderer, of Berlin, and E. Westerman & Co., of Chicago, were the most conspicuous; but each may be said to have excelled in some particular. The exhibit of Joseph Baker & Sons excelled in magnitude of exhibit and variety of machines and apparatus exhibited, and was conspicuous for the extent to which safety appliances were adopted and facilities for manipulating and conveniences for cleaning were employed.

The exhibit of Werner & Pfleiderer came next in magnitude, and was conspicuous for the number and variety of mixing machines for various purposes, for a superior macaroni press, and for heavy brakes for dough, rubber, gutta-percha, etc. This exhibit was especially conspicuous for the extent to which safety appliances were employed and for facilities and conveniences for manipulating and cleaning.

The exhibit of E. Westerman & Co., of Chicago, was especially conspicuous for superb hydraulic and hand adjustable dough-dividing machines, and for cake-cutting and panning machines.

The exhibit of Joseph & Sons, of London, being the most extensive and complete, and their ovens and many of their machines and apparatus being in practical operation, furnishing bread and other bakery products to the Wellington Catering Company, which company operated the different restaurants, or eating houses at the Exposition, and exhibiting as they did the best type of recent development in England, it was deemed well here to give it a somewhat extended notice in order to convey some idea of the manner in which such development was brought about.

An understanding of the development of this industry in the United States, as reported at the censuses of the United States for 1860, 1870, 1880, and 1890, can be obtained from the following table. This can hardly be said to be absolutely correct in all particulars, but is as much so as the record at present shows:

	1860.	1870.	1880.	1890.
Number of establishments	1,930	3,550	6,396	10,448
Capital	$3,909,189	$10,025,966	$19,155,286	$45,758,489
Average number of employees	6,514	14,126	22,488	52,762
Total wages	$2,086,148	$5,353,184	$9,411,328	$23,789,047
Cost of material used	$10,634,199	$22,211,856	$42,612,027	$72,507,579
Value of products	$16,980,012	$36,907,704	$65,824,896	$128,421,535

Much valuable information can be obtained from this table. For instance, the wages of employees have increased as follows:

1860	$322.25
1870	378.80
1880	418.50
1890	545.63

Also that the increase of the value of products over cost of raw materials was as follows:

	Per cent.
1860	59.86
1870	63.46
1880	54.47
1890	95.09

In like manner it can be seen that wages increased between 1860 and 1890 faster than the value of the products over the raw materials, and much other valuable information can be deduced.

The development of this industry in the United States since 1860 has certainly been encouraging, so far as the volume or magnitude is concerned. It would be of interest to know what portion of this development is due to inventions and improvements in apparatus and machines employed in the industry. But no attempt has been made to inquire into this portion of the subject, or to ascertain the State of the art in the different branches to which the various machines and apparatus belong, owing to the time and expense which would be required to do the subject justice.

Reference is requested to the individual reports of judges for more detailed information relating to the machinery exhibited.

BRICKMAKING MACHINERY.

BY

W. C. LEMERT.

BRICKMAKING MACHINERY.

By W. C. LEMERT.

The use of brick dates prior to the time to which our histories reach. In fact, it is said "that the children of Seth, the son of Adam, built two pillars, one of brick and one of stone, and they inscribed upon each of them the discoveries they had made concerning the heavenly bodies, so that their inventions might be preserved to mankind and not lost before they became sufficiently known."

Brick was the building material of the antediluvian days, and it has continued to be building material down to the present time.

In tracing development in the art of brickmaking we find that progress has often been slow and uncertain. It has flourished in ages of prosperity with other arts, and, like them, it has been lost in ages of darkness, but, as with them, it awoke with the Renaissance, and is steadily improving with the progress of time and the spread of knowledge.

In all ages the work required to make bricks has been of the hardest kind, and many have been faint with toil in their production in modern as well as in ancient times. Machinery is doing much to lighten labor, but the old manual method of brickmaking has destroyed many a man in the prime of life, and has undermined the constitutions and wrecked the systems of the most robust natures.

The brickwork of the first two centuries of the Christian era, the crowning period of art in Rome, was superior to any other. In the third century there was barely a perceptible change, but in the fourth there was a most decided deterioration, and brickwork went back with the times, old material being reused extensively, as in the arch of Constantine.

Knowledge of the art of brickmaking has probably at no time become entirely extinct in the East, but after the fourth century, in sympathy with the decline of all other arts and the dying Roman civilization, the knowledge of this art gradually expired, and was lost to western Europe. The art of brickmaking did not revive in England until the thirteenth century; only a few instances of fourteenth-century brickwork occur, and they are toward the close of the style; but in the fifteenth century brickwork became common. Until the first quarter of the seventeenth century the bricks made in England were of many different sizes, but by Charles I, in 1625, their size was regulated and made nearly uniform. After the great fire of London, in September, 1666, brick was the material universally used in the reconstruction.

In 1784 brick were subjected to taxation by George III, which burden was not repealed until 1850, and it is from this period that the general improvement in brickmaking machinery commenced in both the United States and England. From 1850 to about 1870 the soft-clay machines operated by horsepower were mostly used, and in the following we illustrate some of the forms of machinery employed during this period.

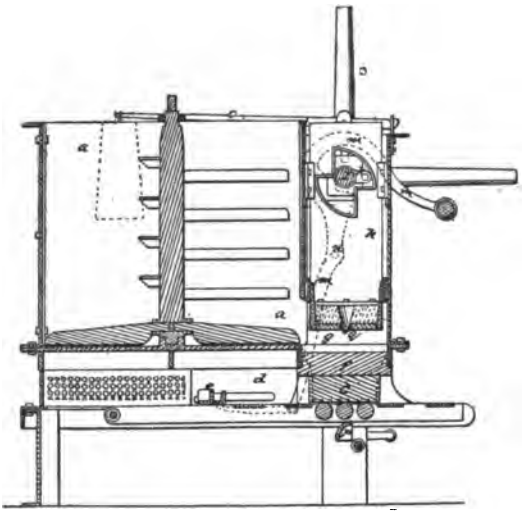


FIG. 1.

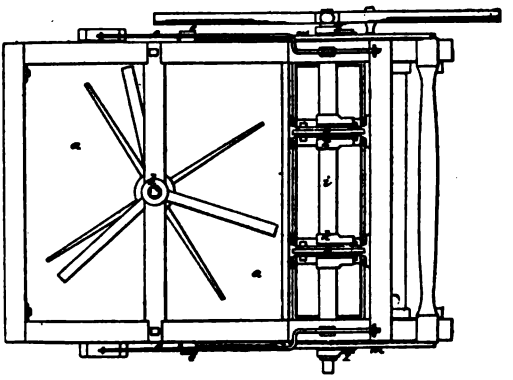


FIG. 2.

Fig. 1 is a section; fig. 2 is a plan.

The machine shown in figures 1 and 2 is the invention of Luther Brown, of Canandaigua, N. Y. It was patented August 5, 1851.

The machine consists of a chamber *a* into which the moistened clay is thrown and is then stirred and mixed by the shaft *b*. The mold boxes, containing each a row of six or eight molds *c*, are pushed into the side of the machine through the opening *d* and at the proper time they are pushed forward by the piece *e*, which places them accurately

under the series of hoppers *f*. The clay enters a cavity *g* above the hoppers *f* from the chamber *a*, and is forced down through the hoppers into the molds beneath by the pressure of an oblong piston working up and down in a corresponding chamber. The piston rises to allow the admission of a fresh charge of clay into the chamber *g* from the chamber *a*, and the filled mold is forced forward by an

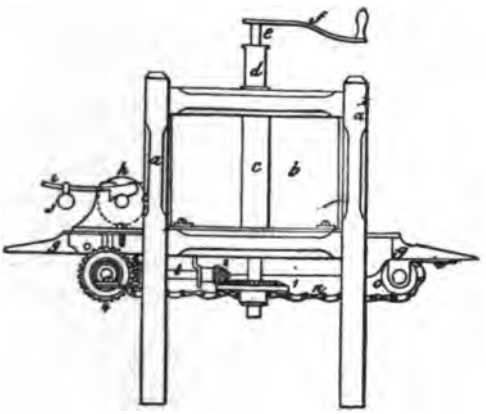


FIG. 3.

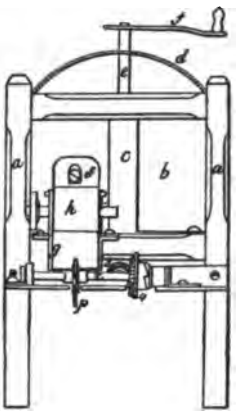


FIG. 4.

empty mold placed behind it, by means of the piece *e*, and the lower side of the hopper and the upper side of the molds being in contact, the bricks are cut off from the clay in the hoppers. The filled mold when pushed out to the front is removed to the drying ground.

The machine shown in figures 3 to 8 is the invention of Samuel Gissinger, of Allegheny, Pa. The machine was patented October 21, 1862.

Figure 3 is a side view of the machine. Figure 4 is an end view. Figure 5 is a top view. Figure 6 is a perspective view of the moldway. Figure 7 is a cut or sectional view of the gauge. Figure 8 is a cut or sectional view of the arms used in the tempering apparatus.

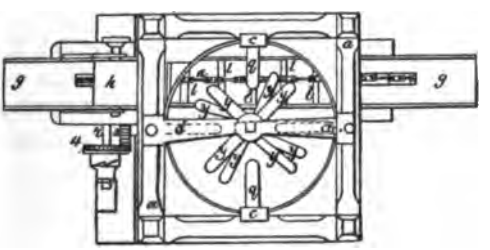


FIG. 5.

The operation of the machine is as follows:

Take clay which is slightly moistened with water and put it into the hopper. Then apply power to the crank or draft beam *f*, which will turn the shaft *e*, which will cause the wheel 1 to operate the wheels 2 and 3 on the shaft *t*, which will operate the wheel 4 and the pulley *p*, which operate the endless chain *n*, which will carry the brick molds along the moldway *g*. The brick molds are of ordinary

construction, and are furnished with bearing-off boards, on the front end of which are placed hooks which catch in the endless chain, thereby carrying the molds along the moldway *g*. The roller *h* will press the clay firmly into the molds as they pass under the roller. The machine is supplied with the molds from the back end of the machine, and the molds as they pass from under the roller *h* are borne off and treated in the usual manner.

The machine shown in figures 9 to 14 is the invention of Henry J. Ferguson, of New York City. It was patented August 28, 1866.

Figure 9 represents a front elevation; figure 10, a vertical section, taken mainly through the line x x in figure 9; figure 11, a rear view of certain mechanism for operating the pitmen that give motion to the plunger and mold-pusher; figure 12, a side view of the slotted arms that operate the pusher, also showing in cross-section the means used for connecting the arms; figure 13, views of the one end of the pitman that actuates the pusher and details connected with the end detached. Figure 14 is a vertical longitudinal section through the

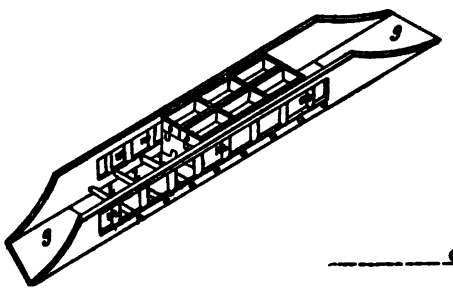


FIG. 6.

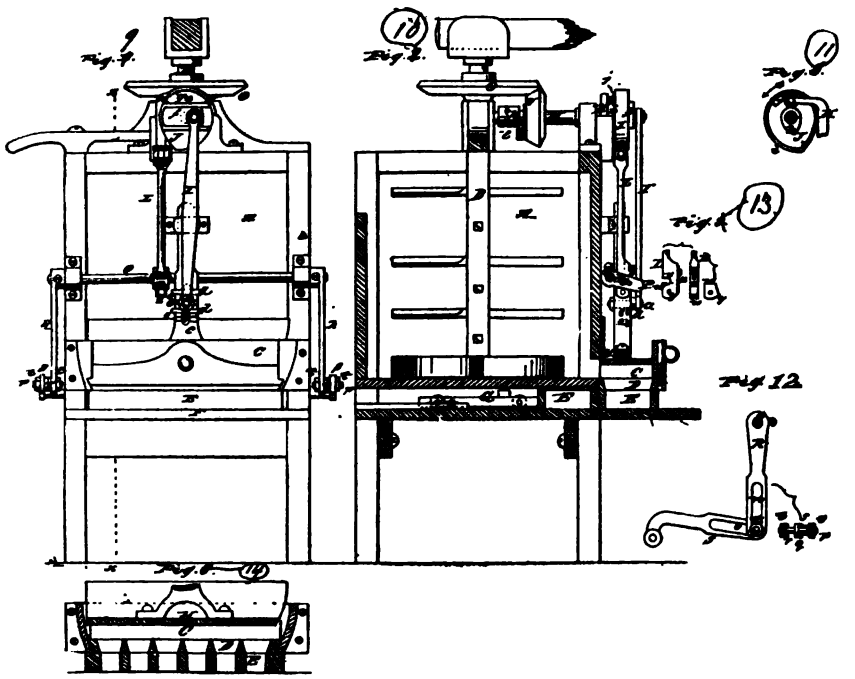
FIG. 8.

FIG. 7.

press box, with parts pertaining thereto. In this machine, as in many others for making brick, there are certain features or principles of action that are so common and well known that it is useless to describe them—such as, for instance, knives attached to a vertical rotating shaft for tempering the clay within a box, and curved arms for delivering it into a press box in which works a plunger that forces the clay through a grating into molds beneath, fed to their place by a pusher. About these things, of themselves, there is nothing claimed as new in this invention, nor yet in the mere provision and adjustability of certain details connected with these parts for regulating the action of the machine and protecting it against breakage in case of excessive strain or obstruction. But what this invention consists in is, first, a novel combination, with the plunger and pusher, through suitable intermediate devices, of a disk on the working shaft, so grooved as to form inner and outer cam surfaces, acting in concert with a slide and serving to operate both the plunger and pusher; and the invention also consists in certain devices for securing a double adjustment of the arms which connect the pusher with the rock shaft that operates

it. A is the box in which the clay is tempered by the action of rotating knives on a vertical main driving shaft B. C is the press chamber. This press box is provided with the usual grating D at its bottom, the spaces in which correspond to the molds E beneath that are placed by hand on a table F in front of a pusher G to receive, when fed up by the pusher, the clay pressed through the grating, the full molds being afterwards replaced by an empty set to keep up a continuity of action.

The plunger H and its gate, which establishes or shuts off communication between the press and the tempering boxes and presses the clay through the grating into the molds, is operated by means of



FIGS. 9, 10, 11, 12, 13, and 14.

a pitman I that is attached in an adjustable manner to the plunger and rotating driving disk J. This adjustability serves to regulate the stroke of the plunger to suit different conditions and natures of the clay, also different thicknesses of bricks, and is effected as follows: The lower end of said pitman has its joint or joint pin *a* made to fit a vertical slot *b* in a standard *c* secured to the plunger, and is held at its required position therein with, if desired, requisite play to insure a slight pause at the end of the downstroke by keys *d* passing through grooves *e* in the standard. These grooves are so arranged as that the keys may be taken out of one set of grooves, and after the plunger has been adjusted higher or lower, driven through another set to hold

the joint pin to its place in the standard. But as it sometimes is necessary, both to meet the adjustment just referred to and independently of it, to lengthen or shorten the stroke of the plunger, the upper end of the pitman I is secured to the rotating disk J by means of a radial slide *f*, held, when adjusted, by a set screw *g*. The driving disk J not only carries the adjusting slide *f*, but is otherwise peculiarly constructed by the arrangement on its rear face of a center cam *h* and outer eccentric or cam-shaped ring *i*, between which lies a roller *j* attached to a vertical slide K that is pivoted to the pitman L, which gives motion to the pusher G, so that said disk when rotated by the horizontal shaft M to which it is secured, and operated by means of a bevel pinion N meshing into a wheel O on the driving shaft B, not only serves to operate the adjustable plunger H but also the pusher G.

A clutch *k* and lever *l* answers to throw in and out of gear at pleasure the pinion N with the wheel O for the purpose of stopping and starting at pleasure the pressing and molding devices.

The pitman L, thus reciprocated at frequently recurring intervals by the action of the cam *h* and eccentric ring *i* on the roller *j*, is made, by its connection at its lower end with a slotted arm, P, to rock a shaft, Q, that has secured to it at either end levers R. These levers have slots *n* in or toward their lower ends, where they are attached in an adjustable manner to horizontal levers S through slots *o*, the back ends of the latter levers S being pivoted to a crossbar on the pusher G. This adjustable connection of the vertical and horizontal levers R and S is of a character that permits of it forming a swivel or joint to both levers, and at the same time a tie to hold them to their relative sets or adjustments, both vertically and horizontally, by means of (see figure 13) a joint pin, *p*, passing through the slots *n o*, and provided with fast and loose collars *q r*, collared loose boss *s*, and tightening nut *t*. In this way the levers R S are not only pivoted together for independent and joint action, but are capable of being adjusted, the vertical levers R more or less outward, and the horizontal levers S upward or downward, to regulate the action of the pusher and throw of the mold box.

To free the molds from action when a stone or other obstruction is forced in with the clay, or otherwise obviate breakage by undue strain, the lower end of the pitman L has its joint pin *u* passed through a slot in the arm P and through a notch, *v*, in the pitman, open at the rear, and said pin made to lie on or over a holdfast or catch, *d*, pivoted at *y*, and held in front by a spring or springs, *z*, which spring or springs are adjustable up or down the pitman to regulate their pressure on the catch *w*. By this means, if any obstruction or undue strain occurs in the rise of the pitman L when the pusher G comes forward to throw out the molds or mold box, the strain on the back end of the catch *w* will cause the latter to tilt and force out the spring *z*, and so release the pitman, which will rise free from gear with the joint pin *u* and arm P.

The machine shown in figures 15 to 17 is the invention of Fred E. Frey, of Bucyrus, Ohio. It was patented August 11, 1868. Figure 15 is a front elevation; figure 16 a plan or top view, and figure 17 shows the pitman *t* with the gearing spring Z attached.

The nature of this invention consists in construction of a portable or stationary brick machine with the clay mill made of suitable material. Through the mill horizontally is run a shaft provided with agitating knives, which intersect with stationary bars or knives running horizontally through the mill, for the purpose of breaking up and mixing the clay in the mill before it enters the press box, into which it is forced through an aperture in the bottom of the mill by the usual scroll-shaped knives. This shaft is provided at its top with two cams which operate by means of suitable attachments, two levers, one of which, in combination with an adjustable pitman and press board, presses the clay from the press box into the brick molds, and the other, by means of suitable attachments, pushes the brick molds, when filled, from under the press box on an adjustable platform and replaces them with empty ones.

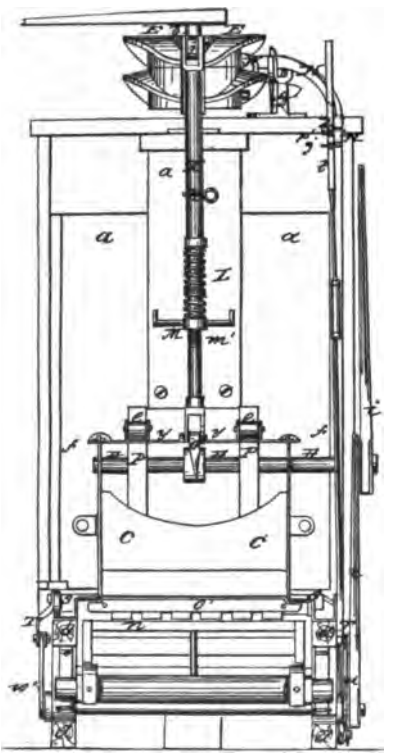


FIG. 15.

a is the pug or clay mill, in which the clay is ground or mixed immediately before it passes into the press box. C is the press box. *b* is the perpendicular shaft, which is provided with the agitating and scroll-shaped forcing knives *b'*, figure 16. *d d* is the lower part of frame of the mill upon which the press box C rests. E E are two cams attached to and revolving with the shaft *b*, which operates the lever H by means of the roller W, and the lever *j* by means of the roller V. *g g* are the fulcra of the levers H and *j*. X, figure 15, is a pitman, which, by the oscillation of lever *j*, operates lever O, figure 15, which is attached to the shaft A and presses the clay from the press box C by means of the pinions *q q*, figure 16, upon the shaft A, working in the racks P P, attached to the press board G', figure 16. *t*, figures 15 and 17, is a pitman, which, by the oscillation of the lever H, operates the angle-shaped lever *w* and lever *w'*, which work the base-pitman T T, attached to the sliding bar S, by means of which the empty brick molds are pushed forward under the gate in the

bottom of the press box C, and the filled molds are pushed forward on the adjustable platform *n* in a condition to be carried to the brick-yard.

The pitman X, figure 15, is constructed, so as to have elasticity, for the purpose of regulating the pressure on the clay in the press box, in the following manner: The upper half of this pitman is made tubular and the lower half solid and of such a diameter as to fit up into the tubular half. *k* is a pin, passing through and secured in the solid or lower half of the pitman, and extends out beyond both sides of the tubular half. Running through this tubular half transversely are slots to enable the pin *k* to be moved up and down and allow the pitman to be held in the position desired. By changing the pin *k* up or down the pitman can be lengthened or shortened. L is a spiral spring coiled loosely around the lower or solid half of the pitman X, with its lower end resting against the screw nut M. When it is desired to increase or decrease the amount of pressure on the clay in the press box C, it can be done by tightening or loosening the spiral spring L, by raising or lowering the screw nut M, which works in the thread *m'*, figure 15, cut for that purpose on the lower half of the pitman X. This can be done while the machine is in motion, thereby adapting it to stiff or hard clay. *y* is an adjustable plate which holds the racks *p p* in their position by means of the friction rollers *e e*, and is adjusted by the set screws *f f*, thereby obviating the customary wear and slipping of the cogs. The pitman *t* is provided with the springs *z*, which clasp the pin *p'* in the lever H by means of the thumbscrew *z'*, thus enabling the pitman *t* to ungear itself should a mold get fast or some other obstruction occur. *n* is an adjustable platform, with rollers, upon which the molds O', figure 15, rest while being filled. *i i* are two hand levers, by which the machine can be used as a hand press, if desired, by detaching the pitman H and *t*.

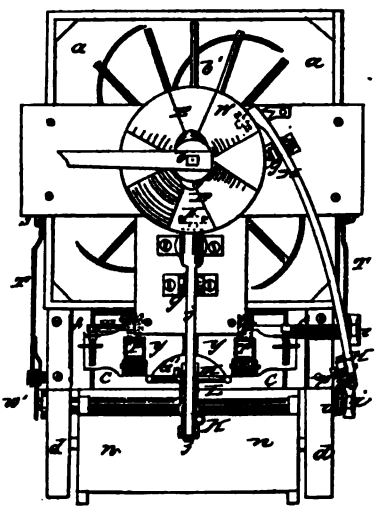


FIG. 16.

FIG. 17.

The machine shown in figures 18 to 21 is the invention of Franklin Whitcomb, of Chicago, Ill. It was patented May 31, 1870. Figure 18 is a front elevation; figure 19 is a side elevation; figure 20, a

top plan view, and figure 21, a horizontal section of the machine, taken on the line $x\ x$ of figure 18. The machine is set in motion by turning the sweep, and is operated as follows: The clay, partially mixed and tempered, is fed into box A, where it is thoroughly tempered by the oblique blades of shaft B, and forced downward until it reaches the arms D, when they force it out into the receiver B below the plunger M, the arms D being so located as to fill the receiver while the plunger is elevated or is ascending. As soon as the receiver is filled with clay, one of the rollers F bears upon the lever G and

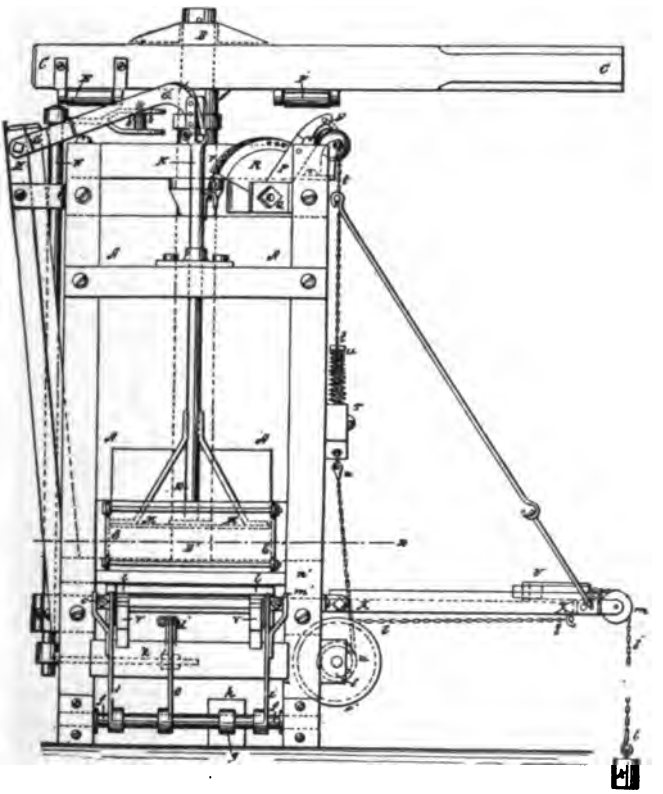


FIG. 18.

forces the plunger M downward, which presses the clay down into the empty mold previously placed below the receiver. When the plunger rod is forced down, the chain r is caused to operate the wheel R and its connections, and operates the head U, which carries another empty mold into the machine, ready to be fed under the receiver as soon as the first one is filled. As soon as the roller passes from over the lever G the weight k draws back the head U and elevates the plunger M; should the parts bind, however, so that the weight will not operate them, the roller, as it travels in its course, will strike the arms P and force back pulley R so as to raise the plunger.

After the roller has passed the lever G and the plunger has begun to rise one of the arms *y* strikes the arm *b*, and through the connections of the latter cause the frame *l* to move forward the empty mold just shoved into the machine by head U, until it is brought below the receiver B', the empty mold as it moves forward displacing the one filled by the previous descent of the plunger, and shoving it out onto the front of the bed V, from whence it is removed by the attendant and emptied. Thus, as the sweep revolves, the rollers F operate the

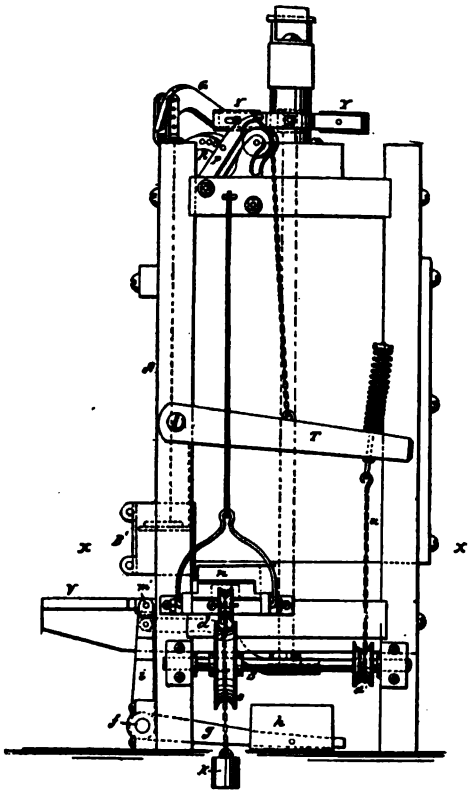
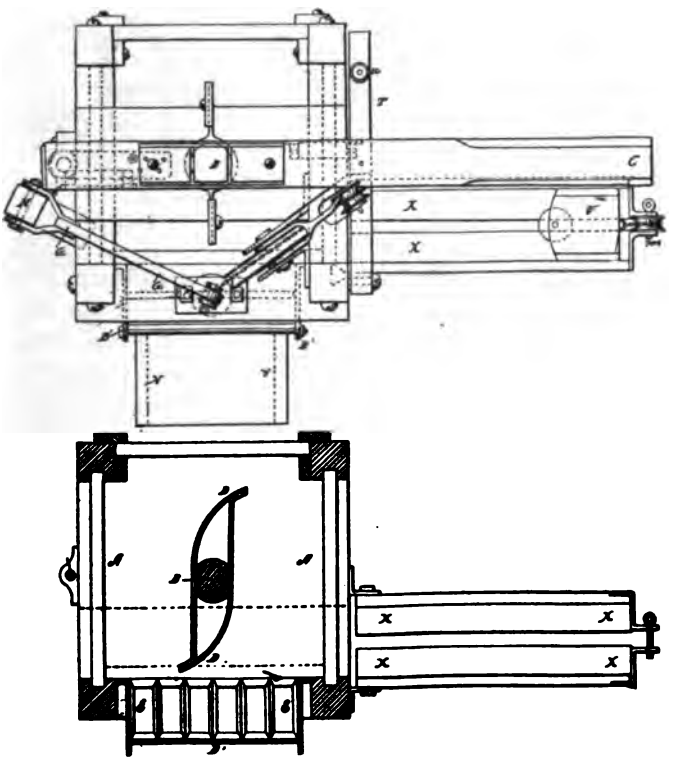


FIG. 19.

plunger and force new molds into the machine, the arms *y* deliver the empty molds to the filling mechanism and the filled molds from the machine, two molds being filled at each turn of the sweep. The pin or roller in the upper end of the plunger rod, upon which the lever G bears in operating said rod, is made adjustable, so that the piston may be carried down a greater or lesser distance, as desired, according to the required pressure upon the clay forced into the mold. The chain *u* is not secured directly to the lever T, but to a roll passing through the same, and provided with a spiral spring on the upper

side, as shown in figures 18 and 19, so as to ease the various parts from the sudden strain that would otherwise be brought upon them in starting the machine, and also from the strain occasioned by suddenly stopping the weight *k* in its descent. The arm Z and the front end of link *d* is provided with a series of holes, so that the points of connection between them and the other parts may be changed as necessary.

From 1870 down to the present time there have been a large number and variety of machines introduced into brickworks. The auger,



FIGS. 20 and 21.

the plunger, the dry-clay and the semiplastic-clay machines are among the number. The plunger machine is now no longer manufactured, thus leaving the field to the soft-clay, the auger, the dry-clay, and the semiplastic-clay machines.

THE MANUFACTURE OF TEMPERED-CLAY BRICKS.

One of the great difficulties usually encountered by the manufacturers of building brick who have established extensive works near large bodies of clay is to get sufficient clay dug, loaded, and elevated to meet the demand for the material. There are a large number of

mechanical clay diggers now manufactured and designed to perform the work described, but the Bernhart steam shovel, built by the Marion Steam Shovel Company, Marion, Ohio, will dig clay enough for from 150,000 to 200,000 brick daily, and by its use modernized yards can enlarge their capacity as desired.

The Purington-Kinbell Brick Company, of Chicago, Ill., has substituted electric power for steam in operating steam shovels used for

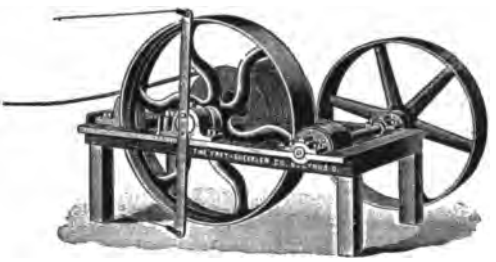


FIG. 22.

the digging of clay, owing to the difficulty experienced in getting coal to the shovel. The apparatus for drawing the clay into the factory by the engine after it was dug, being in the first place cheaper than horses and carts and doing the work without a driver, besides not being at expense when idle, it was a natural result that the winding drum and automatic dump cars were adopted by all enterprising brick manufacturers.

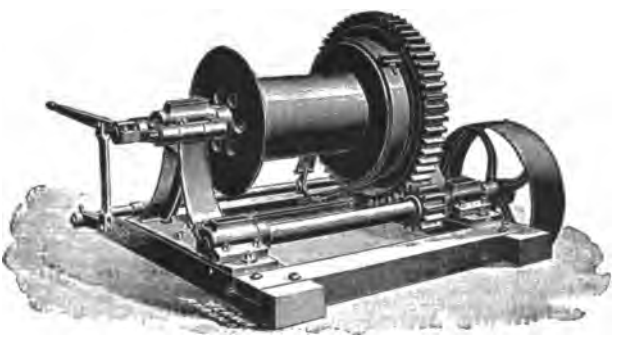


FIG. 23.

Figure 22 illustrates the friction winding drum, which the Frey-Sheckler Company, Bucyrus, Ohio, makes in three sizes. This drum is substantially built. The frame is heavy and is so constructed that it can be bolted to the upper part of the track timber.

Figure 23 illustrates the gear and friction winding drum made by the Frey-Sheckler Company. The construction is strong, simple, and durable. It is not liable to breakage or derangement.

Figure 24 illustrates the side dumping clay car made by the Frey-

Sheckler Company. This car is substantially constructed in all parts. It is made to dump on one side only, but it can be furnished to dump on both sides if desired.

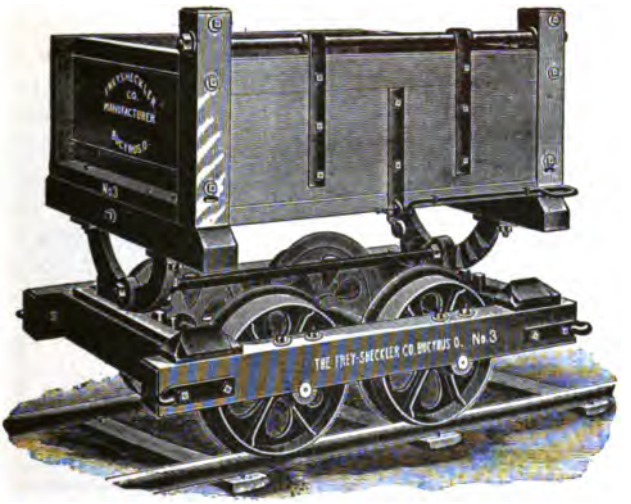


FIG. 24.

Figure 25 illustrates the bottom-dumping clay car manufactured by the Frey-Sheckler Company. The car is remarkably strong. The timbers are heavy and securely bolted together; the wheels, 17 inches

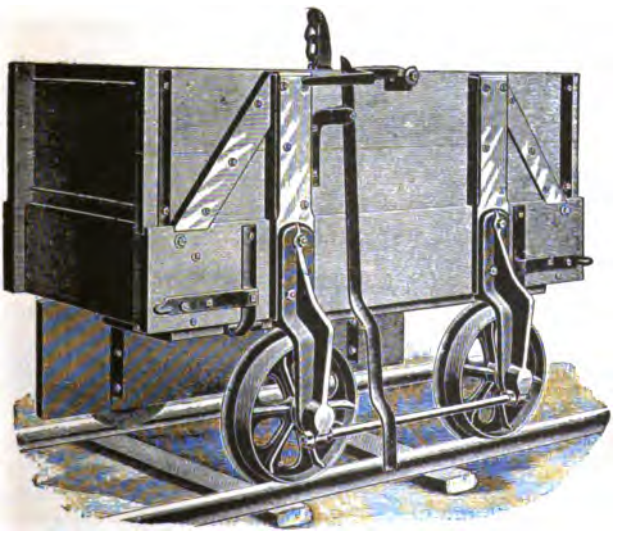


FIG. 25.

diameter, are thoroughly chilled and annealed, and the workmanship throughout equal to the highest established standard. This car is arranged to dump automatically. The clay, having been dug and

brought into the factory by means of a winding drum and dump cars or otherwise, is next to be tempered and prepared for the brick machine. The preparation of the clay must be thoroughly done, for upon this depends in a large degree the quality of the brick produced. The clay should be ground very fine.

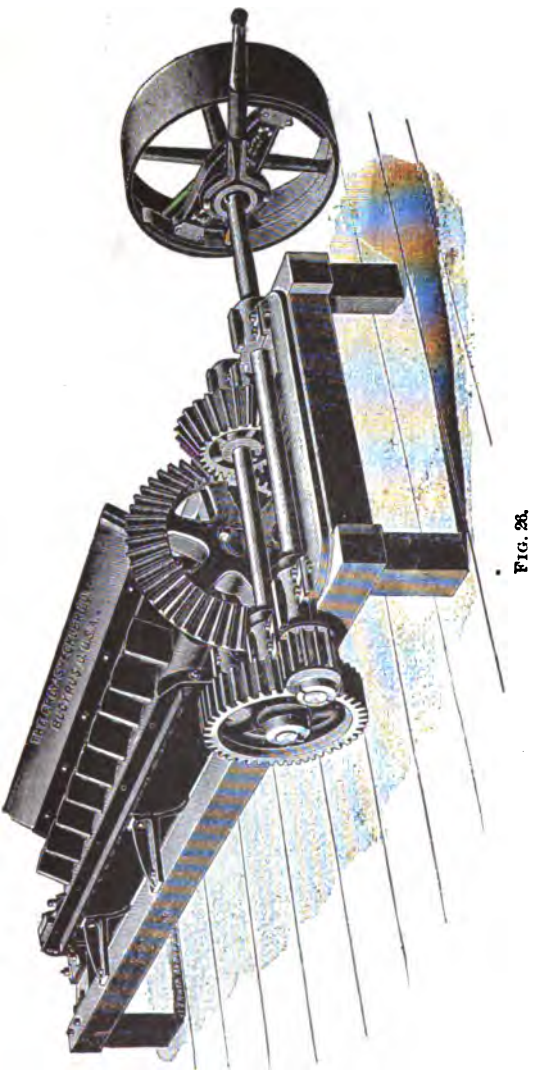


FIG. 26.

Figure 26 illustrates the No. 1 granulating pug mill built by the Frey-Sheckler Company. This machine is used for granulating tough, strong clays before passing to the crusher. This is a very essential feature in clays of this character. Inasmuch as the stones are liable to catch on the knives and break them, a safety pin is inserted in the driving pinion so as to prevent breakage. It also acts as a distributer or feeder for the clay crusher.

Figure 27 illustrates the No. 1 two-roll crusher built by the Frey-Sheckler Company, which is made for exceedingly strong clays. This is a very strong and durable crusher, and is a desirable substitute in places where other crushers have failed owing to weakness in construction.

Figure 28 illustrates the four-roller crusher built by the Frey-Sheckler Company, and which is made in two sizes, viz, Nos. 7 and 8. This machine is very heavy, strong, and durable, and is designed for use in brick factories where large capacity is required. In order to suit the great variety of material to be crushed the Frey-Sheckler Company manufactures three styles of rolls to be

used for the upper pair. For very lumpy and stony clays, either the patent stone separating or conical rolls are used, and for clays of

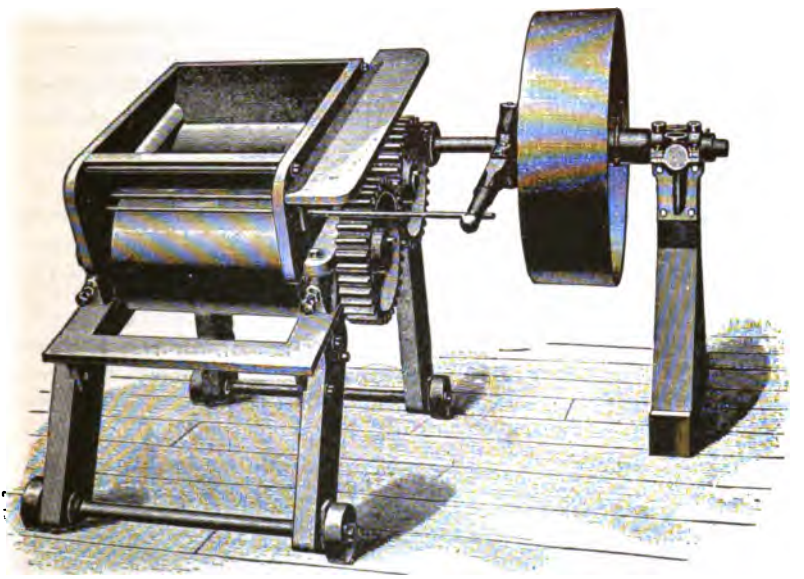


FIG. 27.

alluvial nature smooth-face rolls are employed. The rolls are supplied with adjustable scrapers made of tool steel, which keep the

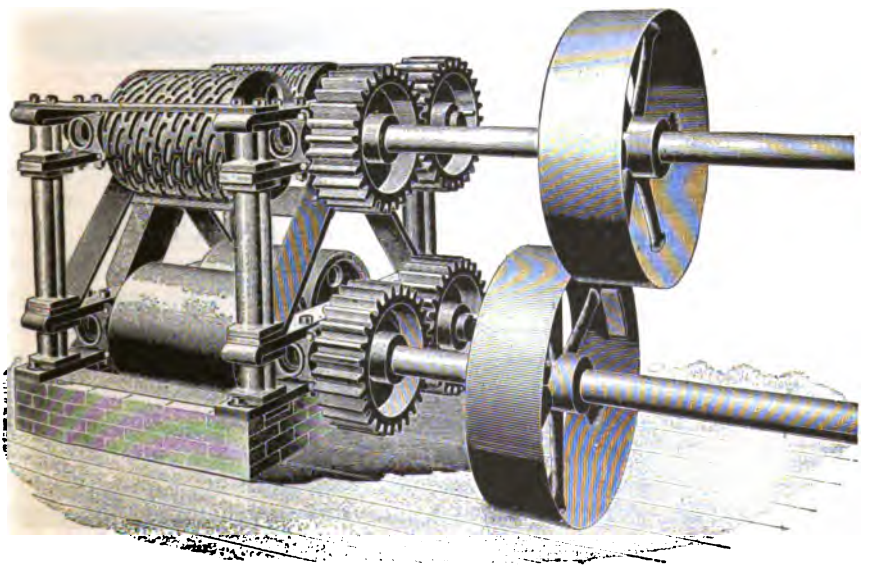


FIG. 28.

rolls perfectly clean. The clay having been ground next passes into the pug mill.

Figure 29 illustrates the No. 2 pug mill built by the Frey-Sheckler Company. This pug mill has a shell made of one-fourth inch boiler steel 8 feet long. It has cast-iron ends. There are two patterns for ends at the discharge of the mill. In one of them the opening is very large; this is used when the clay is of a very sticky nature, and also when large capacity is desired. The other end has a smaller opening and is used when the clay is of a short nature, or when a smaller capacity is wanted.

The builders say:

Our long experience has taught us that wherever dry clay is desired to be mixed with water in the process of passing through the pug mill that an open-top pug mill is the only safe machine to use. The reason for this is that an open-top pug mill allows the examination of the clays all along the course and the introduction of additional water to even it up. Closed pug mills are only advisable when the clay is tempered before entering into them, or when it runs perfectly even in moisture in the bank and requires no additional water. This mill will pug clay for 30,000 to 60,000 brick in ten hours, depending on the nature of the clay and the arrangement of the mixing knives.

FIG. 29.

Figure 30 illustrates a double-geared pug mill made by the Frey-Sheckler Company in two sizes, viz, No. 5, ten feet long; No. 6, twelve feet long. This pug mill has a shell made of ¼-inch boiler steel. The heads are made of cast iron and of the same pattern as is used in their No. 2 pug mill. This pug mill is double-geared, made extra heavy and strong. It can be arranged to discharge the clay either from the bottom or at the end. The capacity of No. 5 pug mill is from 30,000 to 50,000 brick in ten hours; No. 6 pug mill, 50,000 to 75,000 brick in ten hours; depending upon the nature of the clay and the arrangement of the mixing knives. The clay having been properly prepared is now ready to be fed to the brick machine.

For the molding of stiff-clay brick many different machines have been made, and England and Germany stand prominent with the United States in the construction of suitable machinery for this purpose. We have selected such machines of this class as seem to have the most prominent features, together with the latest improvements, for the purpose of description. Before entering upon a detail of this machinery itself,

it is necessary to give the reader a full explanation of the requirements which brick made by this class of machines should meet; also reciting the defects which improper constructions of the molding devices often impart to stiff-mud made brick. Owing to defects in manufacture, bricks often disintegrate in the Northern climates by the action of the weather.

In New York, where the manufacture of brick reaches over 100,000,000 per annum, it was noticed that stiff-mud made brick would not last as well as those made of soft clays, and attention was called to the fact in the national convention of brick manufacturers by experienced and conscientious brick manufacturers. Fortunately some experts of large experience in the manufacture and operating of brick-making machinery were present at the convention, and as those experts were persons of practical knowledge acquired in Germany, England, Australia, and America, they afterward pointed out by publication wherein the cause of the disintegration of the brick could be found, namely, in the improper construction of the molding devices.

A gentleman stated that he constructed a machine in Germany,

FIG. 30.

some twenty-five years since, and obtained a contract from a railroad company to furnish the brick for some buildings along the road; the brick being admired for their beauty and seeming density. After two winters had passed, however, these nice-looking brick commenced to shell off, and presented a very shabby appearance. This led him to study the philosophy pertaining to the flow of clay through dies, and how to prevent the lamination of the clay in the brick, which was the only cause of his ill-success in his first attempt in making stiff-mud brick. He found, like all his coadjutors, that the flow of the clay must be equalized as it passes the mouthpiece, and that the pressure back of it must conform to these requirements. The use of lubricating dies of proper construction and change of forcing augers remedied the difficulties, and the brick that he afterwards made of the same clay, with the same machine, are now as good as when they were put into the walls; this statement being verified by an examination made of the bricks only a short time ago. Manufacturers of this class of machinery in America went through the same experience, but were later in discovering the remedy.

It can be readily seen that when brick are made on a die that does not lubricate the corners properly, the clay will hang back, and that the center will flow faster than the corners. This makes a disruption in the bond of the material, and the brick will be molded with the clay in layers, or so-called laminations. These laminations are generally in an oval form, when made in auger mills, whereas stiff-mud brick made on plunger machines have straight laminations across the narrower cross sections of the brick. The causes of these defects are often found outside of the construction of the molding part of the machine, being also produced when the clay is worked too dry or when it has been improperly tempered.

The defective brick which elicited the acknowledgments of the makers before the convention were made with a machine of excellent construction, but so designed as to force out only one stream of clay for end-cut brick, and at a rapid rate, the opening for the die being in a straight range with the end of the shaft, hence the clay was gathered in from a large area around one central point, which caused the brick to become shelly lengthwise when the clay was being worked rather stiff. To overcome this objection the constructors of the Giant, Acme, Improved Centennial, and Mascot machines have adopted a die for end-cut brick with two openings, and use an auger of large dimensions. These orifices are placed far enough apart to avoid this central point of the shaft, and are spaced so that the pressure of the wings of the screw propellers acts alike over the whole surface of the opening. A very compact and solid brick is the result, even from non-lubricating dies. When the die is made lubricating, after the Niedergesaess patent, very little difference is noticed in the center stream of a three-stream die, if placed far enough away from the propeller. In the Acme brick machine the die front is made telescopic, so as to allow for such adjustment.

While end-cut brick do very well for paving purposes, they are not liked as well by the bricklayers, owing to the smoothness of the surfaces where the mortar is put on, and also because the ends are not as smooth when cut by the wire or knife; whereas side-cut brick have smooth edges all around, and are just rough enough to hold the mortar well.

Until the Niedergesaess patent lubricating brick die was introduced the making of side-cut brick was an uncertain process. Occasionally a quality of clay was found that would work pretty well with a dry die, or the imperfect lubricating dies of the past, yet the defects heretofore named were more or less apparent, while many clays could not even be molded, owing to the tendency of the clay to stick in the corners, especially when the temper of the clay was uneven.

There has heretofore been another serious trouble in having dies retain their proper size so that the brick will be uniform in measurement. In very gritty clay the wear is very rapid, even when the die

is made of hard material. This has also been overcome by the die which is illustrated in figure 31. This die consists of a number of parts, as shown. No. 462 is the casing proper, which contains all the parts represented as spread out below. This bolts on to the mouth of the machine. On top of this casing two bolts are shown sticking out of the water reservoir, which is provided with channels and holes in the bottom to conduct the lubricating fluid or steam through the various channels. The bolts fasten the lettered plate, represented in the foreground, on the reservoir. The hole in the center of the plate is to receive the connecting pipe with valve, also given in cut, which may either lead to the boiler or a water tank, or, if used for repressing, to an oil reservoir.

On the right are shown four cast frames having channels around the edges of them. The left shows the sheet-steel liners which fit

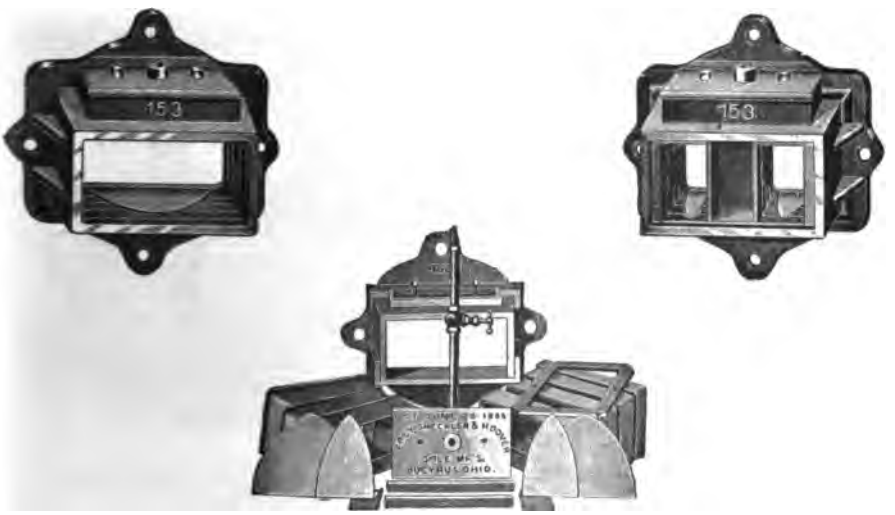


FIG. 31.

over each frame. In the immediate front four sheet-steel plates are shown. These fit into the first frame and make the sharp corners on the brick. When round corners are desired, these are replaced by a liner similar to those on the left. The four round-edged plates in the foreground are termed the aprons, and are put in last over all the liners. The whole is held in by the frame represented on top of the frame on the right. Proper packing, cement or putty, is used to prevent leakage. The duties of the aprons are twofold—to prevent the wearing of the liners and to exclude the lubricant where not wanted, so as to insure an even flow. It is highly necessary that only clean fluid is used, as otherwise the channels will stop up and make the die inefficient. It is well to have a thin-bladed knife to put under the liners occasionally, so as to keep them open for the fluid to emerge and come in contact with the clay as it passes through. For some

clays dry steam answers the purpose better than either water or oil. Weight, 80 pounds. With this die a much larger quantity of ware is made and with less power than on dies of any other construction. This system is now applied by the Frey-Sheckler Company to other kinds of dies besides those for bricks, such as dies for molding flooring tile, grate backs, flue tile, and hollow blocks.

For building brick, sharp corners are demanded, which this die forms very perfectly, while all dry dies must have the corners more or less rounded so as to assist the molding of them.

Figure 32 illustrates the Mascot machine with Daisy cutting table, built by the Frey-Sheckler Company. This machine is admirably adapted to meet the requirements of persons having light power and desiring to operate a factory on a small scale. While embracing the essential features of the larger machines, it is smaller and of less capacity. To run the machine to its full capacity will require about 15 horsepower, depending upon the nature of the clay. The Mascot

FIG. 32.

is adapted to the manufacture of tile from 2 inches to and including 10 inches in diameter; brick from 10,000 to 15,000 per day of ten hours, depending upon the kind and condition of the clay. It is also well adapted for manufacturing hollow building blocks. Speed, 180 revolutions per minute; friction-clutch pulley, 36 inches by 10 inches.

Although the Daisy cutting table is quite small and as only four bricks are cut at a time, it is well adapted for cutting from 15,000 to 20,000 brick in ten hours. One of its many good features is its "down cut," thereby leaving the brick with smooth edges. The abutment plate is hinged. After the cut is made the table is moved back, which releases the abutment plate, allowing it to fall back out of the way in removing the brick, which is done before the cutting frame is raised. In its construction large wheels are used to reduce resistance. A counterweight is attached to the cutting frame which accelerates the cutting of brick. The Daisy can be used for cutting end and double wedges if desired. It is only intended for side-cut brick. The Mas-

cot machine and the Daisy cutting table combined occupy a floor space 4 feet by 13 feet. Combined weight, 2,650 pounds.

Figure 33 illustrates the Improved Centennial brick and tile machine with new pattern side-cut board delivery table, as built by the Frey-Sheckler Company.

One of the many valuable features of this machine is its great pugging capacity. It is provided with two shafts which revolve in opposite directions, one running at a speed five times faster than the other.

The mixing shaft on which the tempering knives are attached is hollow, and the propeller shaft passes through it with a propeller attached on the outer end. By this arrangement complete pugging is assured, also the very best quality of ware produced. The mixing shaft is made of cast steel and the propeller shaft of forged steel. Its great forte is in making a larger variety of work of superior quality than any other machine. It is adapted for the production of hollow building blocks of every description, fireproofing, terra-cotta lumber, drain tile, building and fire brick. The construction throughout is of

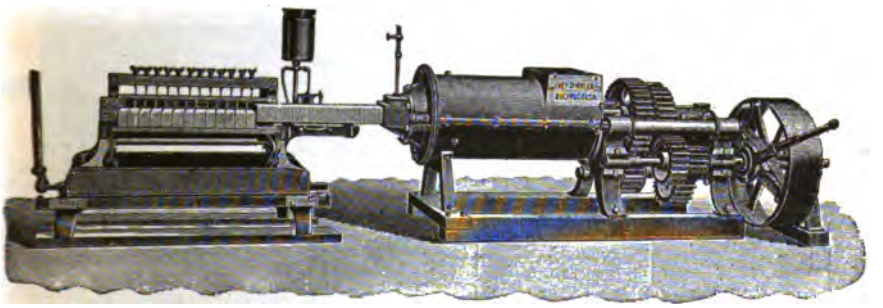


FIG. 33.

the best and simplest. The gears are of new and heavy pattern, having 5½-inch face, 1¾-inch pitch. It has a capacity of 15,000 to 20,000 standard size brick per day, depending on the kind and condition of the clay. A 36-inch diameter, 10-inch face friction-clutch pulley is supplied with this machine, running at a speed of 100 revolutions per minute. The machine proper will occupy a floor space of 12 feet by 4 feet 6 inches. Approximate weight, 4,000 pounds.

Figure 34 illustrates the improved Acme machine, built by the Frey-Sheckler Company. This machine is so well known among clay workers that little need be said as to its merits. The Acme has been on the market many years, and for excellence of performance, size considered, it is to-day without an equal. It will be observed from the accompanying cut that the construction of the main frame is very rigid. The gearing is remarkably strong. The auger shaft is made of forged steel, provided with two bearings 10 inches and 12 inches long, respectively. The auger and knives are made of charcoal-chilled iron, rendering them exceedingly durable. All parts are accessible.

The machine is so constructed that the augers and knives can be readily examined and replaced when necessary. There are no parts liable to derangement. Like all our machines the Acme is provided with a friction-clutch pulley—36-inch diameter, 10-inch face—which places it under the immediate control of the operator. It is adapted to the manufacture of brick, tile, and hollow blocks, making tile as large as 20 inches in diameter. On brick its capacity is rated from 20,000 to 30,000 standard size brick in ten hours. Speed, 200 to 225 revolutions per minute. Approximate weight, 4,000 pounds. Occupies a floor space 9 feet 6 inches by 5 feet.

Any of the cutting tables made by the Frey-Sheckler Company can be used in connection with the Acme machine.

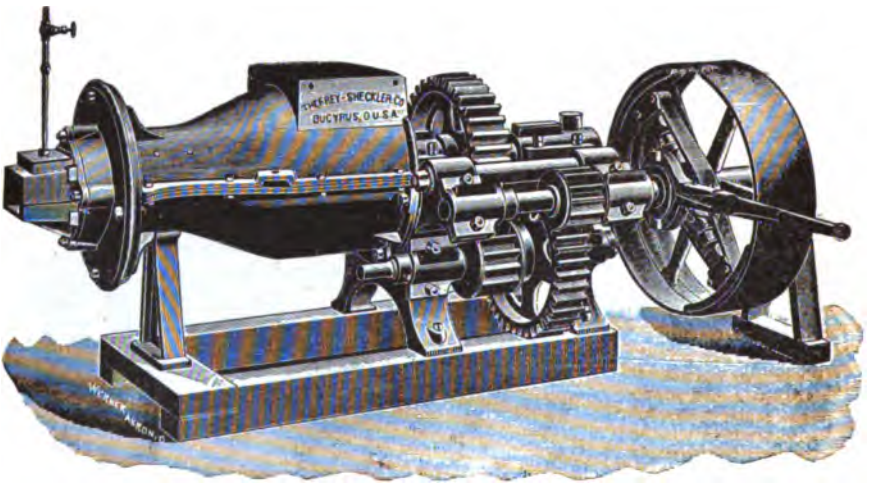


FIG. 34.

Figure 35 illustrates No. 1 Bucyrus Giant machine, made by the Frey-Sheckler Company. The No. 1 Giant is the largest machine manufactured by the firm named. The No. 2 Giant is an exact reproduction of the No. 1 Giant on a smaller scale. These machines are constructed on scientific principles, both in material and workmanship. The material is so distributed as to equally resist the greatest pressure. In other words, they are absolutely self-contained. These machines are provided with strong and substantial double gearing. Each gear is housed, which adds 35 per cent to their strength over the ordinary plain gearing. The pinions are made of steel.

The mixing shaft is made of hexagon forged steel and provided with a suitable auger and mixing knives, whereby the clay is propelled through the die in a continuous stream, which is then cut into brick by a cutting device. The auger and mixing knives are made of chilled iron, evenly ground and polished by special machinery. The auger when worn can be moved outward on the mixing shaft, thereby bring-

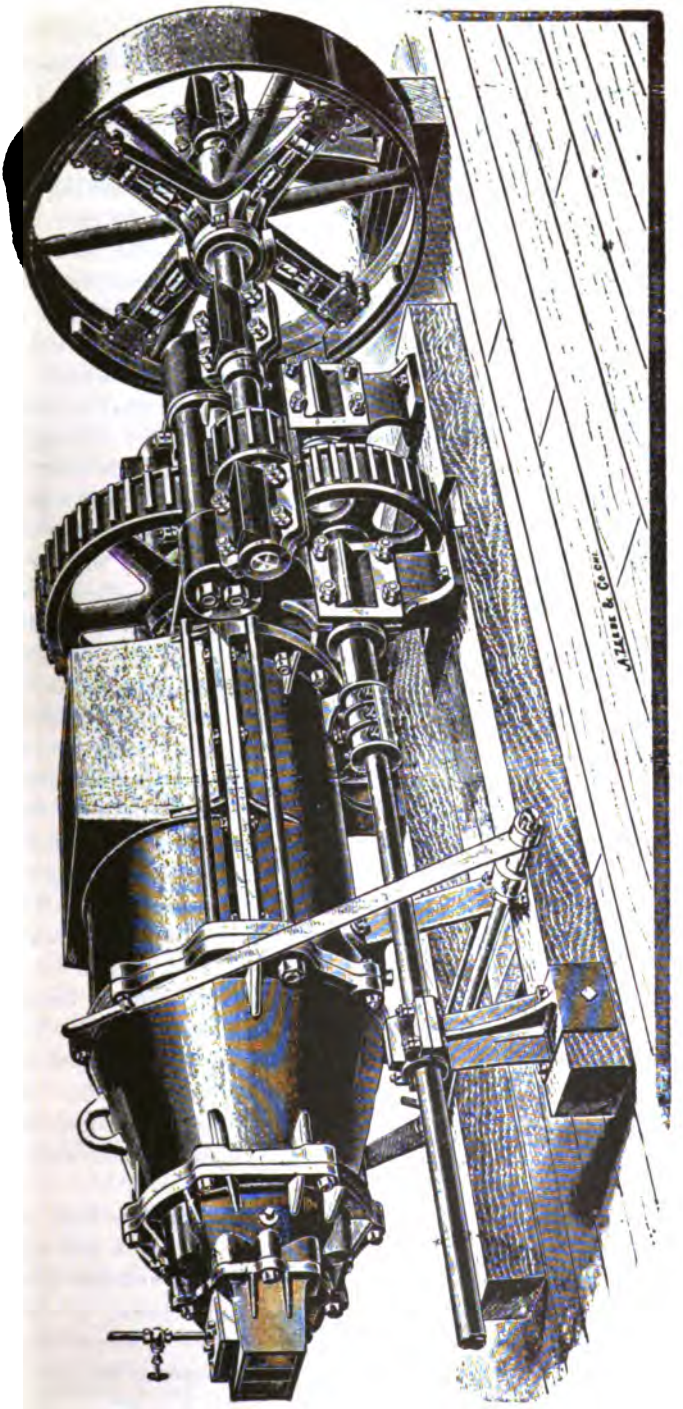


FIG. 35.

ing its edges as near the sides of the tapered cylinder as they were when the auger was new. This is a very important improvement, which doubles the life of the auger and at all times enables the machine to work up to its full capacity.

The Frey-Sheckler Company make two styles of augers, to wit, single and double bitted. The kind used in the machine depends upon the class of ware to be made. The rear end of the mixing shaft is provided with a hard chill disk, which is attached to and revolves with the mixing shaft against a stationary chill plate, and between these two chilled surfaces is placed a patent phosphor-bronze disk. These parts receive all the wear from the end thrust of the mixing shaft, and can be replaced at a nominal cost. They are adapted to the manufacture of common, paving, and fire brick, hollow blocks, drain tile, Portland cement, etc. The die front is hinged to the nozzle for convenience in cleaning or removing the die. The driving pulley is of a friction-clutch type, which enables the operator to start or stop the machine at will. The driving pulley on No. 1 Giant machine is 48 inches diameter, 12-inch face; speed, 225 revolutions per minute. Capacity, 50,000 to 80,000 standard size brick per day of ten hours. The driving pulley on No. 2 Giant machine is 42 inches diameter, 12-inch face; speed, 200 revolutions per minute. Capacity, 30,000 to 50,000 standard size brick per day of ten hours.

The different methods of drying bricks may be classed as follows: First, when bricks are spread out on the ground to be dried by sunshine; second, the shed system, where stiff-mud brick are hacked under sheds and dried by natural air currents; soft-mud bricks are dried on the same principle by the use of racks and pallets; third, by artificial heat, the first and oldest method of employing artificial heat for desiccating bricks being to dry them by laying or hacking them on a hot floor. This is known as a hot floor or flue drier. This floor is heated by a system of flues passing under it from furnaces at one end to stack at the other end. The second method, by the use of artificial heat, is the tunnel system, where brick are put on cars, either hacked on the bottom of car or resting on hacking pallets. The cars are passed through heated tunnels, and when dry are carried direct to the kiln on the cars. Of this class there are several kinds. Another plan is to place them in cupboards and drive hot air through them by means of blowers which supply heat to the cupboards through hot-air pipes.

The disadvantages of drying bricks in the sun are that they are exposed to rain and frost, and the percentage of brick damaged and lost will average 15 per cent. Again, there is no certainty about the supply of sunshine; while it is furnished without price, it is also furnished without regularity, and sometimes for two weeks at a time no bricks are dried; hence the brickmaker who depends on this process of drying has an uncertain output indeed. Still there is much more

certainty about the output than there is about the number he may put into the kiln. There are only six months in the year during which they can be dried in this way, and only a part of this time is available. Where bricks are made in great quantities a large area for drying the bricks is needed, as it must contain nearly a week's production. This necessitates the moving of the brick long distances from machine to yard and from yard to kilns, and also the handling of large quantities of lumber to protect the brick, which requires a great deal of labor and destroys in a season many thousand feet of the very best lumber. The advantages of sheds over the sunshine process are there is no loss by storm and no lumber to handle.

The pallet system is advantageous with soft-mud brick, for they can be dumped from the molds at the machine. This prevents sticking in the molds, and when placed on pallets they can be put in racks one tier above another, and a large quantity can be stored in a comparatively small space, and when the racks are provided with projecting roofs or canvas sides they save the brick from damage by rain, so that shed drying and the rack and pallet system are great improvements over the old methods, but are open otherwise to the same objections that the sunshine method is, that bricks can not be dried in damp weather.

The general advantages of artificial drying over natural are many, without reference to the advantages of one mode of artificial drying over another mode of artificial drying. With an artificial dryer and a machine capable of producing 25,000 bricks per day, a brickmaker can make 6,000,000 to 7,000,000 per year. To dry without artificial heat it would require two machines of 25,000 capacity to produce the same number of bricks in a year. Now, with one-half the labor, tools, power, and consequently little more than half the capital, he produces the same results. He then gives his employees steady work, and in this way obtains and retains a better class of men for perhaps less wages. There is much less worry and responsibility; he has no anxiety about a storm coming in the night and damaging or destroying his day's product, or perhaps a week's labor may be swept away and his yard left in such a condition that he can make no more bricks for several days. With proper drying facilities the manufacturer can contract to sell his bricks for future delivery, knowing he can fill his orders without being compelled to carry a large stock; instead of having to make his brick in the autumn for the spring market he can sell his entire product up to the end of the year and begin in January or February, and have bricks ready for the early spring market.

In partially drying machine-made bricks for re-pressing, soft-mud bricks are usually carried from the brick machine to the yard or drying shed, where they remain until they are in condition for re-pressing. Just here many have their greatest difficulty, as the brick will dry more rapidly on the surface than inside, especially the angles and

corners, and by the time the center of the brick is stiff enough to stand handling the surface is too hard to re-press. What is needed at this point is to equalize the moisture that remains throughout the brick by taking the bricks and setting them in close hacks; then cover them with canvas or old carpets that have been moistened; let them remain a few hours; when uncovered they are ready to re-press; part of the moisture in the center has come to the surface, and every part is ready for pressure and handling. After being re-pressed, the soft-mud made bricks are often finally dried on a hot floor by setting them on end, and in this way it is possible to finally dry them in three days. To set them on end without injury they must be pressed quite stiff. The safer way is to place them on edge or on their flat side to dry. Where the hot floor is not used, the bricks are often placed on smooth pallets to dry. Semiplastic clay brick may be pressed direct from the machine, as they are then sufficiently dry to be handled from the re-press without injury. Until a few years ago the greater portion of all bricks were dried in the open air.

One of the difficult problems for solution by brickmakers has been the successful drying of brick and other clay products. The hot floor, heated by coal fires, was the first artificial drier known to the trade. About 1864 the iron floor, heated with exhaust steam by day and live steam by night, came into practical use among firebrick manufacturers. The next important step forward was the hot-air tunnel drier, heated with coal fires and smoke, so that when the brick came out dry, both the brick and the workman had a negroloid appearance, caused by the smoke and dust from the coal used adhering to the brick while in a moist condition. Aside from this objection, the danger of the buildings being consumed by fire was very great. The extreme wastefulness and consequent cost of drying brick by this method was the means of soon sounding the death knell of this drier.

In or about the year 1874 the steam tunnel drier was first introduced, and at its inception was a very crude affair, being built without any provision for draft or circulation, and, owing to repeated failures, it was known by many brickmakers as a "sweating box;" but, as the clay-working industry progressed year by year, and as the perfection of a more economical and successful drier became the great desideratum of the trade, strenuous efforts were made to overcome the defects of the first attempt, resulting in various modifications of and additions to the original design.

Another candidate soliciting the brick manufacturers' favor was the tunnel drier, heated with coils of steam pipe and the hot air circulated by a large revolving fan placed at one end. This process has, so far, not met with any perceptible encouragement, because of the fact that many clays will not stand the cyclone of hot air violently thrown upon its surface by the action of a fan, causing checks and cracks in the brick. The necessity of constantly keeping a man employed to operate a special engine day and night to run the fan

proved to be one of the chief elements in destroying the usefulness and economy of this process.

A subsequent rival was the steam tunnel drier, with natural circulation, effected by the use of air ducts and one or two large stacks. By this method the whole amount of saturated air is drawn through and around the brick hacked in the end of the dry kiln near the stacks, superadding moisture thereto, and tending to make the brick very fragile.

To overcome all the difficulties encountered by the foregoing processes, the Frey-Sheckler Company were led to manufacture what is known as the "Bucyrus steam tunnel drier." The circulation of this

FIG. 36.

drier is as near perfection as it can be. Cold air is first admitted to the warm air chamber in the "attic" of the drier, and, after becoming heated, it is drawn into the tunnels by means of many warm air ducts, and is discharged in the middle of the track, directly under the cars of brick, through a double series of hot pipes, by which the air is given a very high degree of heat. The air then passes upward, through and around the brick which are hacked on the car, and when the air is laden with moisture it is carried off by the draft of vapor stacks, which at no point are over 8 feet away. One of the many excellent features worth attention in this drier not possessed by any other is that each tunnel is built entirely separate from the other tunnels, and

while all of the tunnels are under one roof, they are separated by division walls, and each tunnel can be operated independently or in connection with the others, so that when one tunnel of brick is dry the steam can be shut off from the same. Then, again, where large plants are erected to meet the requirements of large outputs, and in case a reduction in the output is desired at any time, the drier can be cut off to any desired capacity, as each tunnel is governed by its own pipes and valves.

There are a large number of these driers in practical use by brick manufacturers and they are well pleased with its operation. Figure 36 shows a view of a Bucyrus drier, nineteen tunnel (from discharge end).

After being dried the brick are ready to be set in the kiln and properly burned with wood, coal, or oil fuel.

DRY-CLAY BRICK.

The machinery designed and used for the manufacture of brick from dry clay has not heretofore produced a good merchantable brick, strong enough to meet the judgment of builders, dense enough to resist moisture and frost. Yet there are recent modifications of machinery which provide for added moisture to the clay and which has resulted in the production of brick which fairly overcomes the former defects and obviates criticism, making the brick a semiplastic rather than a dry-clay brick.

Dry-clay brick are a failure for strong building material. The semiplastic brick remedies this to a large extent by changes made in the mechanism of the machine on which they are made, which allows more water to be added to them before they are molded, but they are still inferior in strength to stiff-mud brick, and are unfit for roadway paving brick and similar engineering work.

We will embody here the report made upon dry-clay brick at the World's Columbian Exposition held in Chicago in 1893:

Goldie & McCulloch, Canada, No. 6489, brick press. Design: Parts well proportioned and though numerous are compactly grouped. Construction: Mechanism and material good. Operation: Dry granulated clay is fed through a chute to the charge boxes, which deposit it in steam-heated molds. Pressure by toggle-joint is then applied so as to compress the clay from both top and bottom. The green bricks are then discharged from an off-bearing table. Efficiency of performance: It is agreed that a machine should be judged by what it is and what it does. Does this machine produce any desired or intended results, viz, the manufacture of strong, durable, cheap building brick of uniform shape and color from dry clay?

Brick thus made are of varying strength, as it is impossible to deposit in each and every mold an equal quantity of clay, uniform in granulation and dryness. The grains of clay have no natural tendency to unite under mechanical pressure or in the kiln; hence it is impracticable to obtain such a per cent of marketable brick as to be profitable. Such brick lack bond, there being no natural adhesion between the granulated particles. After burning to the point of vitrification, it is a mass of vitrified particles, not a vitrified mass; it is brittle, glassy,

and, being nonabsorbent, makes a weak mortar bond. If not vitrified, the brick are weak and porous, invite moisture, and are disintegrated by weather changes that engender efflorescence of alkaline formations upon their surfaces.

They are unserviceable in pavements, culverts, sewers, and other engineering construction, as the water and the gases, even in the burned brick, separate the granules of clay.

Clay is the only mineral possessing plasticity. Water added to clay renders its

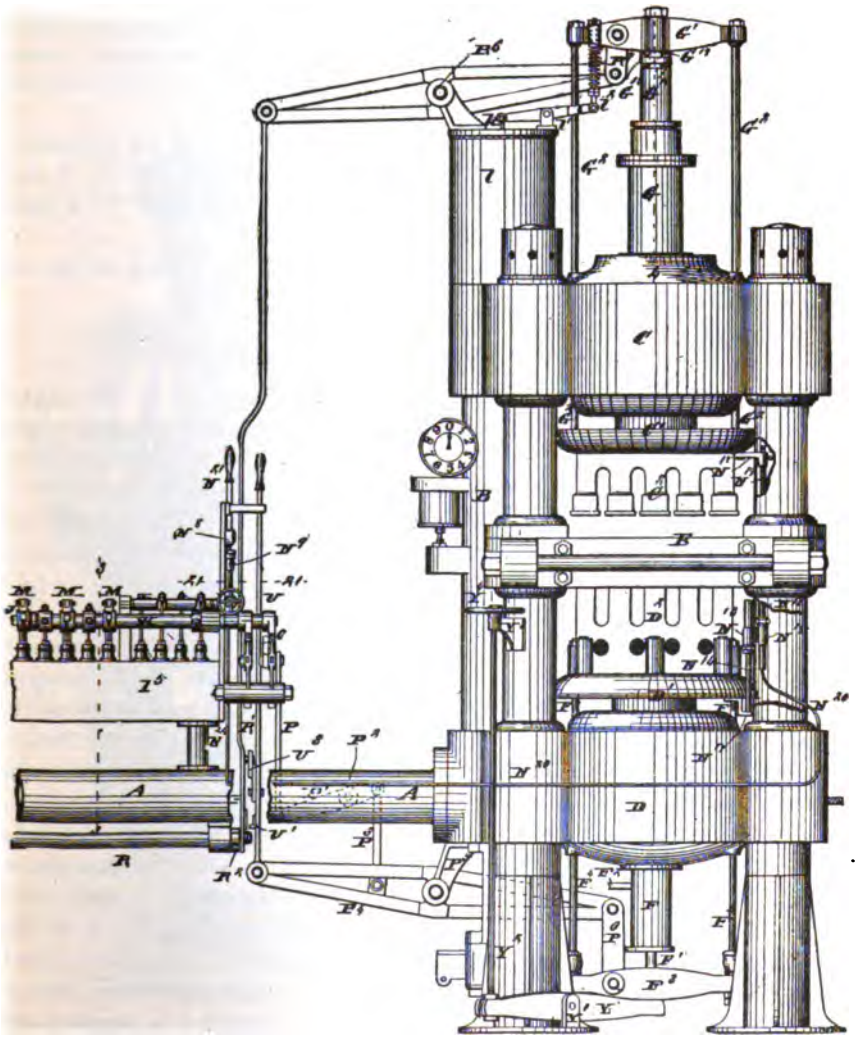


FIG. 37.

grains soft and cohesive; kneading blends and unifies the mass, imparting evenness of composition and strength of structure—both essential attributes of clay for brick—but with which this machine seeks to dispense.

A mechanical fault not overcome by this machine is the confinement of air, with the clay, in the molds, which, if not forced out before the maximum pressure is applied, weakens the green brick by expansion of the imprisoned air after the pressure is relieved. Repeated or increased pressure aggravates the fault by forming dense surfaces, which prevent the gases generated in the kiln while burn-

ing from freely escaping; therefore the brick expand and become porous, like dough, under the influence of years.

This machine and its auxiliaries, for the same output of brick, cost double that of any other process. The water smoking and burning requires longer time, more fuel, more skillful labor, and costs 25 per cent more for these items than tempered clay brick. Prolongation of burning also demands increased kiln capacity. The kilns are necessarily down-draft and expensive.

It is true a handsome brick may be made on the machine, with skillful operators, by the careful selection of strong clay, containing exactly sufficient fluxing elements; but the manufacture that involves high-priced machinery, careful selection of clays, skilled labor, tedious manipulation, excessive cost of burning, will pass the commercial limit of cost. No award.

Figure 37 is an elevation of brick machine, operated by hydraulic power, patented September 15, 1885, by Willis N. Graves, of St. Louis, Mo. It is designed for making brick from dry clay, and is a good machine of its class.

This class of machinery costs too high, however, to permit of its general adoption in brick works.

THE FREY-SHECKLER SEMIPLASTIC BRICK PRESS.

After more than thirty years of practical experience in the manufacturing of brick and brick-making machinery, the Frey-Sheckler Company introduce to the trade a machine founded on more modern principles than heretofore devised by any other manufacturer.

In the construction of this machine they have endeavored to design one that would completely fulfill the most exacting conditions, and in doing so they have every reason to believe that their machine, which is shown in figure 38, is the strongest representative of its class, for the following reasons: First, it exerts greater pressure, which is retained on the brick until they are delivered from the mold; second, simplicity in construction, easy accessible, and immense strength; third, it leaves no granulations on the outside surface of the brick; fourth, all the rectangular edges of the brick are perfect. After the clay is fed into the mold it first receives a constant and gradually increasing pressure, both from above and below. The second pressure is brought to bear on the clay when the brick is near the bottom of the mold by an ingenious mechanical device of the massive, steel-lined cam. The third and final pressure is applied upon the brick by the two massive cast-steel connecting rods on each side of the press, which pressure is retained on the brick until the upper pressure foot is entirely out of the mold. By this method is insured a perfect and highly polished brick. The clay hopper and mold charger are steam heated, thus preventing any clogging or adhesion of clay. The upper and lower pressure feet are also steam heated, which conveys the heat to the mold and prevents any sticking. The amount of clay entering the mold can be varied while the machine is in operation by the hand-wheel shown on the right-hand side of the machine. To change the thickness of brick the upper pressure plates can be adjusted in a few minutes. The mold box and pressure plates are lined with the best

grade of hardened steel, and are easily removed, when worn, for regrinding. The liners are made reversible. All the shafts are made of forged steel. The pinions are made of cast steel. The main spur gears and pinions are housed to the pitch line, thus adding a surplus strength of 35 per cent over the ordinary straight-face gearing. This

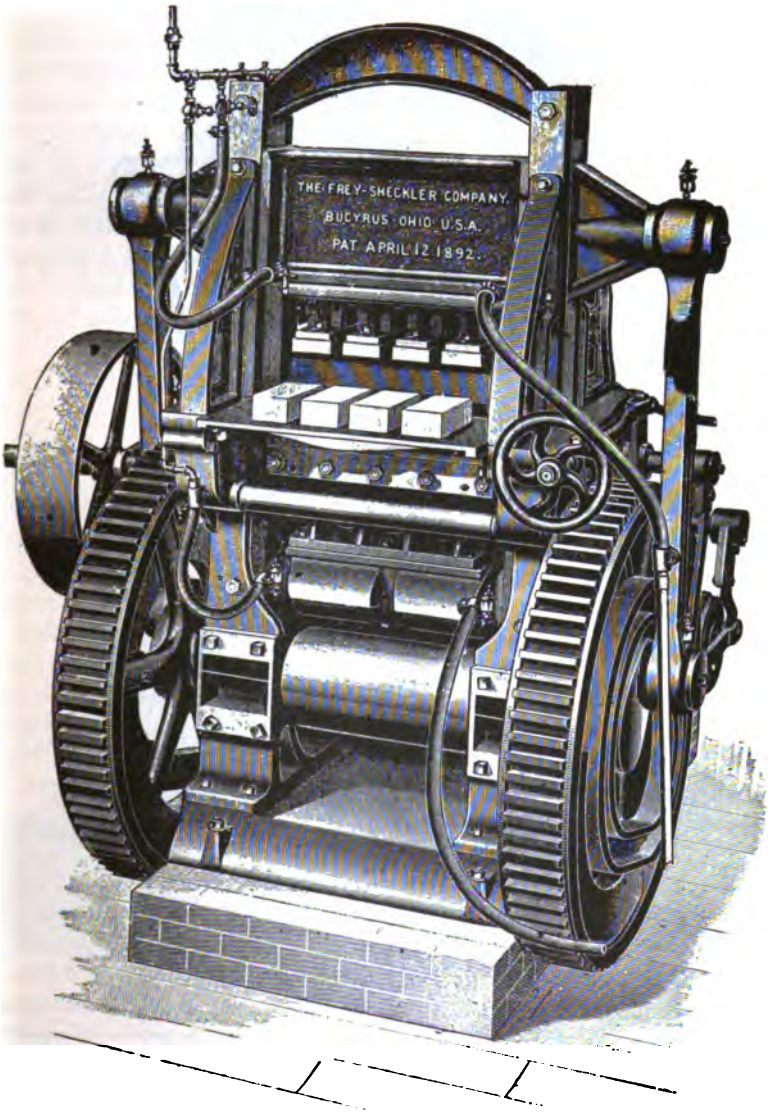


FIG. 38.

machine is built in two sizes, to wit: Two and four mold. Capacity of 2-mold, 10,000 to 12,000 brick per day, will consume about 4-horsepower. Capacity of 4-mold, 20,000 to 25,000 brick per day, will consume about 8-horsepower. These machines have been thoroughly tested and are sold under a guaranty.

THE PANEL RE-PRESS.

We show in figure 39 a cut of the Panel re-press manufactured by the Frey-Sheckler Company. This is the first and only machine of its class manufactured in the United States.

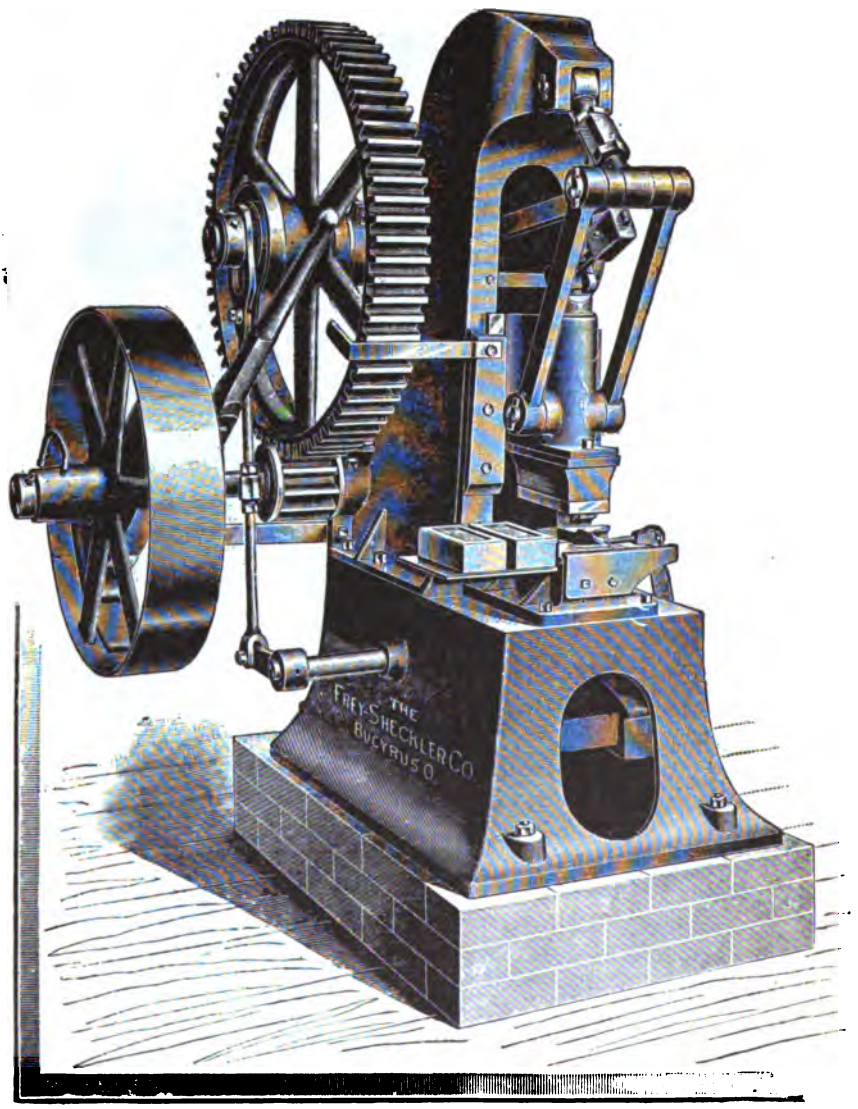


FIG. 39.

It is especially designed to meet the wants of brick manufacturers producing a high grade of brick for enameled glazing, where it is very essential to have all of the brick of an exact thickness. It is

also adapted for pressed and ornamental brick when a fine finish of product is required.

This machine is constructed on new and scientific principles, as will be seen in the cut. The shafts are made of steel. The gears are extra heavy and of a new design. The machine is mounted on an extra heavy cast-iron box bed. It is simple in construction, easy accessible, and no parts liable to get out of order. All of the gears and mechanical movements are so arranged as to be entirely free from clay, etc., so as to prevent wear. The feed and discharge of the brick in this machine is strictly automatic. Machines of this class from abroad do not enjoy this ingenious mechanical device, but must be stopped at the pressing of each brick in order that the same may be removed from the mold. This machine is supplied with a friction clutch pulley so as to enable the operator to start or stop the machine at will. Capacity from 6,000 to 10,000 highly finished brick per day. Weight of machine, 4,500 pounds.

THE EAGLE RE-PRESS.

In figures 40 and 41 we show a front and rear view of the Eagle re-press, manufactured by the Frey-Sheckler Company.

This machine is designed for re-pressing paving brick, also face brick, in either plain or ornamental shapes. The manufacturers claim for the Eagle unequaled strength, rapidity, and efficiency. The main shaft is made of 5-inch diameter hammered steel, thus reducing its liability of breaking to the minimum. The gearing is very strong and massive, having 6-inch face. The four side rods connecting the heavy gearing with the upper cross head are made of hammered steel. The press mold into which the brick drop is stationary. The pressure feet, which are attached to the upper cross-head, exert a downward pressure, while the lower pressure is exerted by a cam on the main shaft operating in connection with the lower cross head. No other re-press gives the brick both an upper and lower pressure.

The machine is supplied with a double mold box, so that two bricks are re-pressed at each stroke, thus giving twice the capacity of a single mold repress without any additional expense. The mold box is planned and fitted nicely, and lined with a special high grade of steel. The oiling devices in connection with the press are automatic.

The machine is very simple in its construction; it has fewer wearing parts than any other re-press manufactured. It is easy to keep in repair and working order. Its operation is perfect. This machine re-presses the brick direct from the brick machine without cutting or injuring the brick. In feeding the brick they are first placed on the table into an automatic feed and forced automatically into the mold

box and are subjected to a pressure from the top and bottom. The lower pressure foot, after applying its force upon the bricks, continues its upward movement, thus carrying the re-pressed brick to the top of the press mold. The automatic feeder, with two more brick,

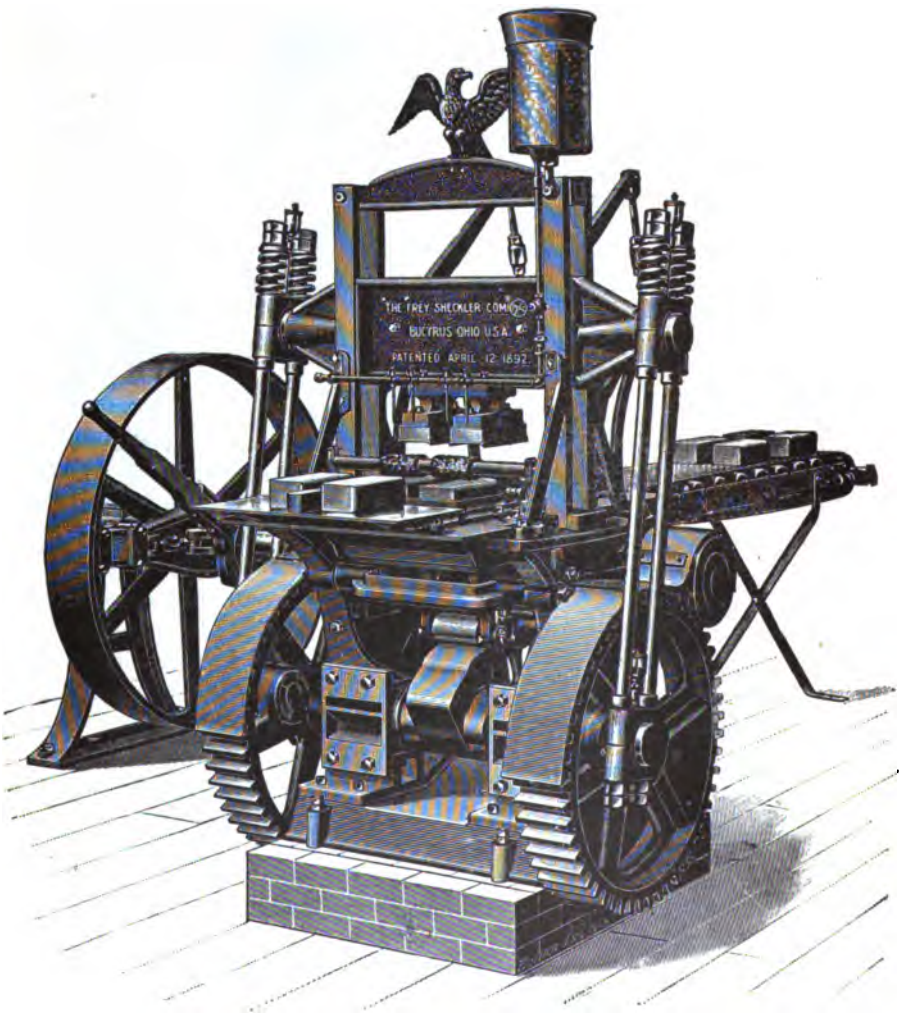


FIG. 40.

comes in contact with the two brick already re-pressed, forcing them to the carrying-off belt, from which the hackers convey them to drying cars or trucks, preparatory to taking them into the drying tunnels. This machine is supplied with our friction-clutch pulley, 48 inches diameter; 7-inch face; speed, 40 to 80 revolutions per minute.

Its capacity is from 10,000 to 28,000 standard size brick per day of ten hours, according to quality of product desired. The power required is from 1 to 2 horsepower. Weight, 7,500 pounds.

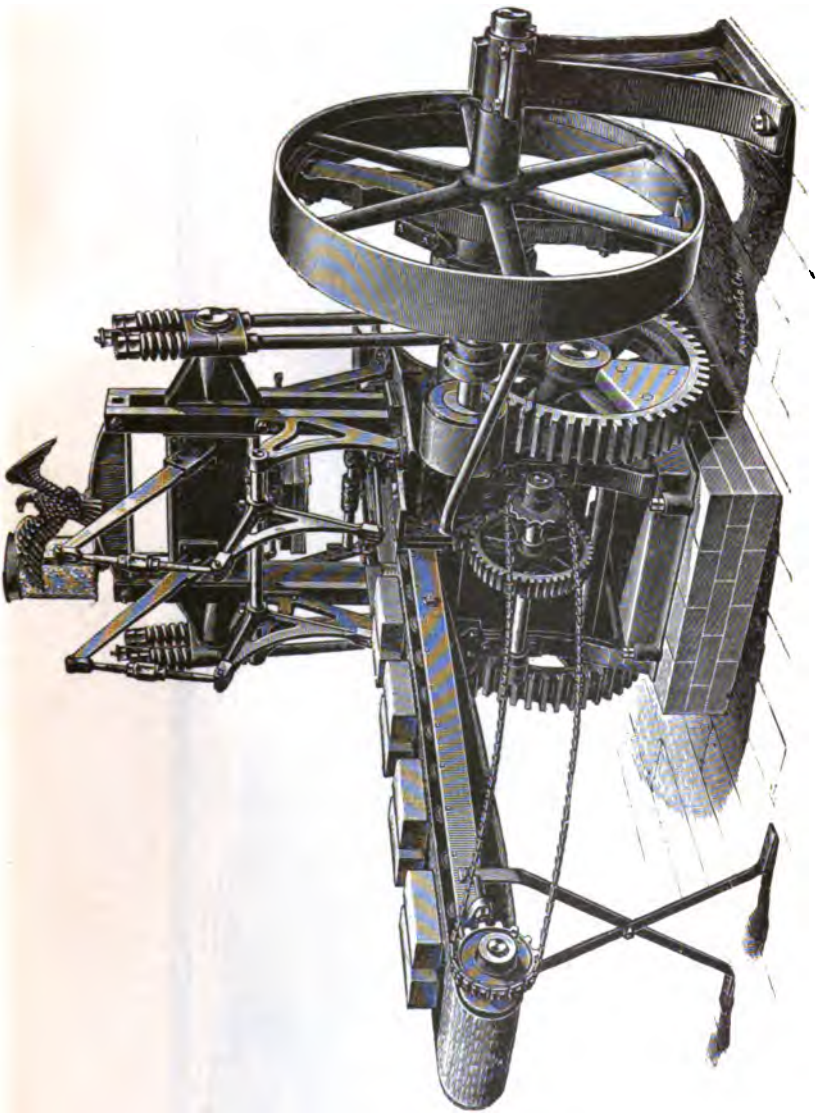


FIG. 41.

SPECIAL BUCYRUS GIANT MACHINE.

Figure 42 illustrates the Special Bucyrus machine made by the Frey-Sheckler Company.

The mixing shaft is made of hammered steel, 5½ inches in diameter,

hexagon, where the knives are fitted on, and 6½ inches in diameter where the large spur wheel is fitted on. The intermediate shaft is

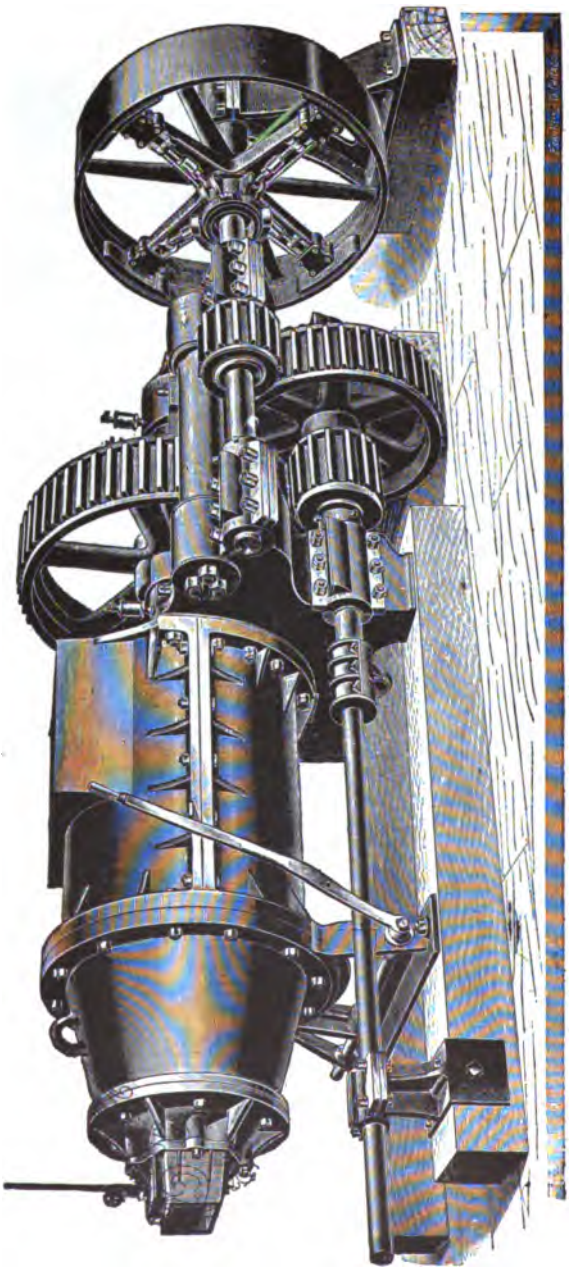


FIG. 42.

made of hammered steel, 4½ inches in diameter where the intermediate gear and pinion are fitted on and 4 inches in diameter at the bear-

ings. The driving shaft is made of hammered steel, 3½ inches in diameter. The gearing is of latest design, extra heavy, and strong. The main spur wheel and spur pinion are 10 inches face and 12 inches

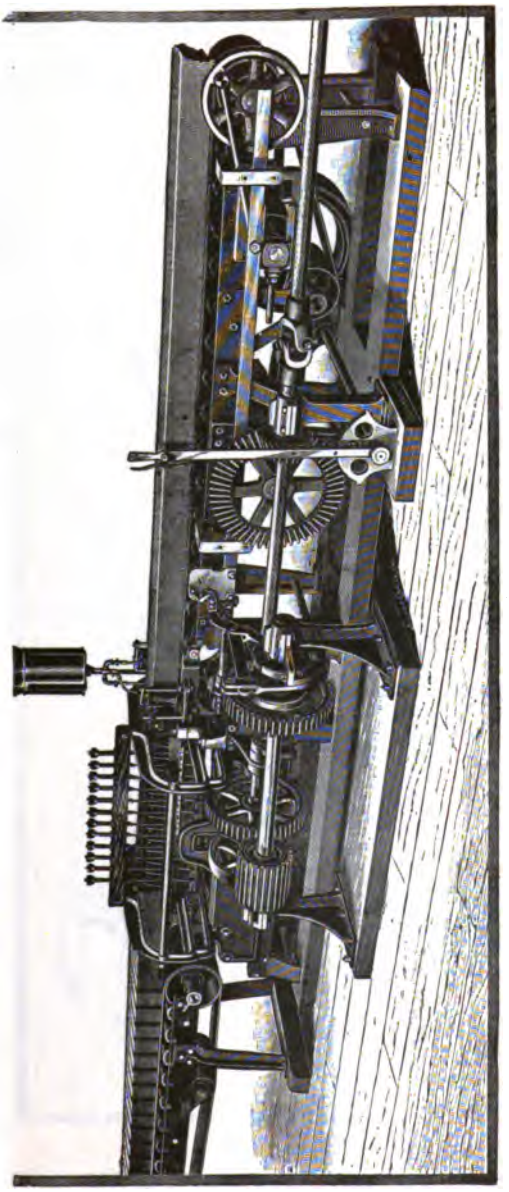


FIG. 43.

over housings, 2½ inches pitch. The intermediate gear and driving pinion are 8½ inches face and 10¼ inches over housings, 2½ inches pitch. Both the intermediate and driving pinions are made of cast

steel. By having the gearing housed the manufacturers secure from 25 to 35 per cent more strength on the same size gear than on the ordinary plain gearing. The machine is backed geared 12 to 1, which renders a very strong and easy motion. The driving pulley is of our friction-clutch pattern, 48 inches in diameter, 12 inches face; speed, 300 revolu-

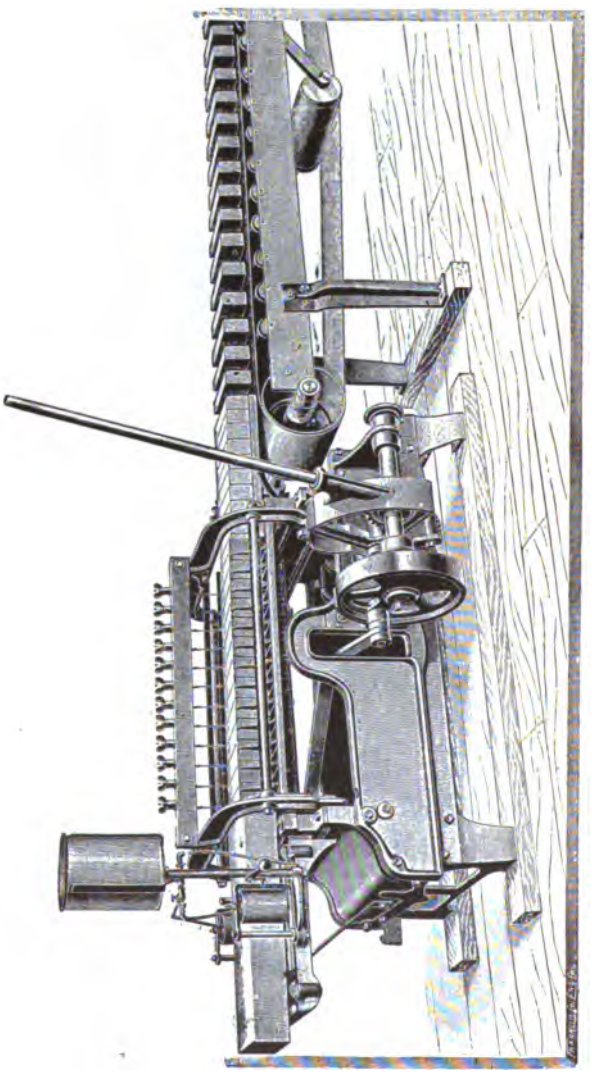


FIG. 44.

tions per minute. The concaves are securely fastened to the front gear frame; the side and end flanges are planed and bolted to each other; the flanges are ribbed to the body. The opening in the top concave is 24 inches by 24 inches. The nozzle is planed on both ends and securely fastened to the concaves. The front which receives the dies

is also placed on both ends so as to make a perfect joint. It is secured to the nozzle with extra-heavy cast-iron hinges, thus enabling the operator to clean the machine or remove the die readily. The front end of the machine is supported with an extra-long leg, which is bored out to fit the turned end of the concave and nozzle. The gear frames are made extra heavy so as to give surplus strength. They are planed and fitted together nicely. Both bearings of the main shaft in the gear frames are 18 inches long, 5½ inches in diameter. The bearings of the intermediate shaft are 14 inches long, 4 inches in diameter. The bearings of the driving shaft are 14 inches long, 3½ inches in diameter. Over the chill thrust plates in the rear gear-frame cap is placed a Ballantine compression grease cup, which will always insure the most perfect lubrication at that point. The caps over the bearings are all planed to fit the frames nicely. The oil chambers in these caps are large and provided with suitable covers to exclude the dust. The outer end of the pulley shaft is provided with a good and substantial bearing, 14 inches long, 3½ inches in diameter. Capacity from 50,000 to 80,000 standard-size brick per day of ten hours, depending upon the quality of the clay, temper, and treatment. Approximate weight, 20,000 pounds.

Figure 43 illustrates Bucyrus side-cut automatic table, made by the Frey-Scheckler Company. It cuts any number of brick desired, from 20,000 to 80,000 daily.

Figure 44 illustrates the Wellsville side-cut table, made by the Frey-Scheckler Company. It will cut from 20,000 to 70,000 bricks in a day of ten hours.

BRONZES.

BY

L. G. LAREAU.

BRONZES.

By L. G. Lareau.

This class was fully and worthily represented at the World's Columbian Exposition. The importance of the class will be recognized at once when it is known that it comprised bronzes of all kinds, such as art bronzes proper, and decorative bronzes, as well as all other art metal work, whether chiseled or repoussé, outside of gold and silverware or plate and jewelry. Contributions from all parts of the world were on exhibition, and in no department did the Far East make a better display than in this one. Japan, of course, was the most prominent oriental contributor. A special report will be devoted to this exhibit, so that very little need be said here. The numerous pieces on exhibition showed that the Japanese still retain the secret of clever handicraft and perfect treatment of metallic surfaces. They are past masters in patinas, and their founders have not forgotten how to produce these wonderful alloys which filled their Western competitors with envy when Japanese productions first reached European markets. All manners of special bronzes were well represented, and fine examples of Shakudo, Shibuichi, and Nashiji were to be found. The art of inlaying has been carried to the utmost limits of perfection; there are evidences, even, of the danger that mere skill in tool handling and patience may replace true art feeling. The best pieces were plainly inspired by the art of the two preceding centuries, and it would be hard to detect any sign of the birth of a new school. It is quite enough, indeed, to keep up to the magnificent standard of the seventeenth and eighteenth centuries, for even this implies a continuance of the same inspiration, of the same spirit of faithful representation of natural objects. Unfortunately, the free intercourse with Europe and the demand created for Japanese objects by the first exportation of old metal work gave birth to the manufacture of wares made for foreign trade only, in which artistic value was the least consideration. There are healthy signs that Japan is trying to shake off this fungous growth. Yet there were still numerous examples of decadent Japanese art to be seen in the manufactures building in the shape of large flower vases of hybrid shapes, neither Japanese nor anything else, thickly plastered with inlaid full-sized leaves and flowers. The workmanship was excellent—the more the pity. Fortunately, the good exam-

ples exhibited by Japan's best modern art workers stood there to show that the tradition was in no danger to be lost. To anyone not so prejudiced in favor of old work that he would refuse to look at any object made since 1850, it was very plain that there are many artists in Japan whose aims are high and whose works in this special line can not be rivaled by any of their Western competitors. To speak only of the exhibitors in the manufactures building, it is safe to say that in the hands of such men as C. Suzuki, or K. Ishii, and many others too numerous to mention, art metal work in Japan is bound to hold its own and make a long stride toward regaining a reputation which a too mercenary spirit had temporarily dimmed.

The other Eastern contributions with class 585 of Group XCIII came mainly from India, who made the usual and trite display of Benares brass and Tanjore copper with their traditional patterns and rather rough workmanship. Siam showed wares of the same kind and some silver repoussé which, although derived from India sources, evinced considerable originality. Ceylon and Persia were also represented in a small way, while the Ottoman Empire sent its Damascus inlaid and pierced brass ware made into card receivers, bowls, trays, mosque lamps, etc.

The display made by European exhibitors was important and interesting. It is evident that this branch of art industry is in the hands of progressive men, and though in some cases the desire to produce cheaply plainly led to doubtful results from an artistic standpoint, the general drift was toward higher standards. France was represented by her best bronze manufacturers, who sent a bewildering quantity of well chosen and finely finished models, both in art bronzes proper and decorative bronzes. Austria was strong in finely finished examples of bronzes of all kinds and tasteful "Vienna articles." Germany had a representative exhibit of the various kinds of bronzes; Russia showed her collections of small bronze groups, and nearly all the other European nations had one or more examples of their art metal work. Great Britain had no exhibit in this class. Mexico and Argentina represented America outside of the United States. The home exhibit was good and showed very encouraging results with so young an industry. Abstention on the part of some notable manufacturers rendered it less interesting than it might otherwise have been. In one direction, however, was the United States exhibit remarkable—in the employment of metal for decorative purposes as shown by the Tiffany Glass and Decorative Company.

The bronze court of the French section was one of the most interesting spots in the manufactures building. Here nearly all the French firms exhibiting bronzes were gathered, and the endless profusion of meritorious bronze objects of all kinds showed conclusively that the men at the head of this branch of art industry were not asleep on their laurels, but by a careful choice of models and improved

methods of working, insuring adequate reproduction, sought the accomplishment of higher results from an artistic standpoint. The whole prolific field of French culture was called upon to furnish fit subjects for reproduction in bronze, and every method of surface treatment and chisel handling known to the craft was employed to render accurately the spirit of the model. The conviction on the part of artists that their works, if meritorious, can be so successfully reproduced in a readier form may play a larger part than usually acknowledged in keeping up the high standard which French sculpture has reached and seems to retain. In surface effects some novelties were presented, especially in the treatment of pseudo bronzes or zinc alloys. Outside of the well-known polychromous effects produced by electro deposition and colors upon zinc, there were to be seen some remarkably well-finished imitation bronzes, complete illusion being obtained by means of finely colored patinas and high-class workmanship. In decorative bronzes, as used to adorn furniture or for panels, candelabras, clocks, etc., the French exhibition was very strong. The dexterous use of the chisel and the scrupulous care with which each part was finished was a delight for the connoisseur of technical hand work. The degree of excellence in that respect, though not uniform among the various exhibitors, never fell below a certain level, and if there are in France manufacturers who produce these cheaply made varnished bronzes of ornamentation of doubtful taste and inferior workmanship they did not trouble themselves to come to Chicago.

The only adverse criticism that might be offered against French small bronzes is that they present nothing new with regard to style; the designs are in nearly all cases inspired by the age of Louis XIV and his successors in the eighteenth century. This leads to an apparent sameness in the productions which is rescued from monotony only by the consummate skill of the artists employed in the work. It seems strange at first sight that the French ornamentists have not succeeded in extending the boundaries in the field of their labor, but the reasons for this state of things are many and powerful. In the first place, the eighteenth-century styles, as applied to this special branch of artistic work, combine many features to commend them. In no other period was so much art spent on decorative and gilt bronzes; the sumptuous architecture of Louis XIV was exacting in its requirements, and demanded from the designers in this special branch the exercise of care and judgment. The task fell in the hands of men whose talent can not be questioned; a robust elegance, fullness of forms, exquisite treatment of curves, and nobility of general effect are the main characteristics of a style which influenced the art of small bronzes throughout Europe. It tempered the exuberant fancy of the Italian ornamentist; it was imitated in Spain, but never thoroughly understood in England; Germany swallowed it whole, but digested it

badly. This art is essentially French, indigenous to the soil; Bérain, Gouthière, Caffiéry, Delafosse, and many other French names are its glories, and the deep root it has taken in the national taste explains in part its continued vitality. Nor should it be forgotten that, at the present day, the designs for such objects are not left to the care of indifferent men; the greatest artists do not deem it beneath their dignity to attach their names to a clock, a candelabra, a vase, a table service. Carrier-Belleuse, Mathurin-Moreau, Piat, Lafrance, Mallet, Chéret, and others design decorative bronzes. In the hands of such men the design, though strictly within the boundaries of a certain style, acquires a value due to the personality of the designer; it is not a lifeless copy, it is a creation which compels the admiration of an enlightened public. Hence the perpetuation of a style which, with all its faults, is perhaps more in keeping with the present state of civilization than the more rigid forms of preceding ages. Yet in this slavery to style lies a danger made greater by the very cleverness of those who bear its shackles; advance is checked and the springs of invention dried up.

The renowned house of Barbedienne, whose name is a synonym of fine treatment of surfaces, had a generous exhibit. Though lacking in new models, the collection was thoroughly representative of the firm, and fully up to its reputation. Among the art bronzes some well-known productions picked from the best ancient and modern models were found. Dubois's four symbolical figures for the tomb of Lamoricière were conspicuous, as well as a fine choice of Barye's animal groups, a standard specialty of this house. A good reduction of Mercié's "Gloria Victis" was also on view. Many other pieces, like the "Jeanne d'Arc," by Chapu; "Orpheus," by Raoul Verlet; "The Dance," by Delaplanche; "Admiral Coligny," "Clothilde de Surville," etc., were exhibited, showing the high skill in the treatment of surfaces for which this house has become celebrated. A fine example in that line was the large Cæsar Augustus, on the surface of which all the resources of the modern bronze finisher has been exhausted; the different parts of the armor, the flesh, the hair, each being chased in the manner most appropriate to render the texture, and treated with the patinas which made the name of Bardedienne famous when he first produced them. But while giving due praise to the models presented and the methods employed by this firm, it is well to note that an exacting critic would probably point out the fact that the former are not by an means new, nor have the latter changed for the better lately. In this field of manufacture the producer should not nod on his laurel, for the present generation is alert and the scepter is safe in no hand. But if an admonitory criticism may be offered in regard to the art bronzes produced by this firm, its decorative bronzes can easily be praised without reserve. Leaving aside the designs, which in nearly all cases are models of taste, the chasing, gilding and general

finish are such as to excite well-deserved admiration. The exhibit was rich in such examples; large and small candelabras, clocks, and chimney garnitures, ornamented vases, etc., all showed a remarkable care of details and jewel-like finish. Among the many pieces an ebony and gilt bronze cabinet by Constant Sévin was conspicuous; also a large mirror frame and "porte-émail" by the same artist, all pieces inspired by the eighteenth century, which bore the stamp of the modern artist.

The old firm of Thiébaud Brothers, with its full century of traditions and its official connection with the State and city of Paris, had an exhibit in keeping with its years and experiences. The numerous examples were treated in a manner which left but little to criticise. The patina effects were, in the main, sober and strong, as might be expected from a firm whose work consists largely of monumental figures; but the careful finish and skillful chiseling displayed in their smaller pieces showed also a thorough familiarity with the secret of treating bronze from an artistic standpoint. The larger Doré vase, "La Vigne," was the most conspicuous feature of the exhibit. It stood 13 feet high, in the center of a hollow square, around which the smaller pieces were placed. It is too late to discuss the artistic merit of this well-known production; it remains only to speak of the execution, and it can not be gainsaid that the many difficulties which it entailed have been overcome with consummate skill. The casting is from a cire-perdue mold, without a flaw or blemish. Among the fine examples exhibited by this firm may be mentioned a remarkable cire-perdue Mephistopheles, by the Russian sculptor Antocolski, a striking piece, the dark patina of which accords well with the subject; also a "Dante" treated in the same tone. "The First Burial," a reduction of Barrias's beautiful group, attracts attention, as well as Indrac's "Salambo," which, though reduced to a little less than 18 inches in height, preserves in full that peculiar facial expression for which the original is noted. "On the Ground," by Boucher, an admirable study of muscles, is thoroughly well expressed in the bronze. "An Ancestor," by Massoulle, is treated in a vigorous manner. "Victory," by Coutan, a high relief full of fiery emotion, is reproduced in a polished bronze, finished with a rich and very effective reddish patina. Many other figures and groups might be mentioned, such as "Thought," by Chapu; "Love and Lion," by Injalbert; "Treasure Trove" and "The Victor in the Race," by Moulins; Falguière's "Diana," etc. Some strongly modeled flowers and leaves, and a fountain and vase adorned with flowers, all cast in cire-perdue molds, should be noticed, as well as a number of fancy articles, such as grotesque vases, and cabinet-size reductions in polished bronze applied to artistically made inkstands and other ornamental household articles.

Susse Brothers made a display which was remarkable both for a fine

discrimination in the choice of models and the skillful manner in which the metal was treated. This firm seems to be fully aware of the dangers of routine in art manufactures, and puts forth a manifest effort to widen the field of bronze reproduction by varying the effects, suiting the finish to the subject, and broadly representing the manner peculiar to the artist they interpret. Their use of the chisel is not simply to insure a smooth surface, attractive to the eye, but to faithfully reproduce the sculptor's work, which thus preserves its originality and personal characteristics. The tendency of all the works on view was toward broad and simple effects, careful and intelligent chisel work being preferred to showy patinas and other more popular means of attracting attention. This collection was therefore particularly interesting in exhibiting a progressive tendency which the most casual observer could not fail to notice. It was rich in works made specially for the Columbian Exposition, among which may be mentioned in the front rank a boldly executed reduction of Rude's magnificent bas-relief "Departure for the War," sometimes called "The Marseillaise;" a remarkable "Columbus," by Peynot, a work of art which, in its dignified force and noble simplicity, was head and shoulders above the many images of the great navigator at Chicago, most of them forced products from the quadricentennial hothouse; "the Bou Saada Maiden," by Barrias, a triumph for the sculptor and the bronze manufacturer. The figure as reproduced has all the strength and poetry of an original. The chisel has been so skillfully handled that it has all the qualities of a cire-perdue cast, and the use of quiet patinas to distinguish the flesh from the draperies imparts to the figure a lifelike appearance which, though striking, does not overstep the boundaries of true art into realism. The "Mignon" of Maugin is treated in a broad and simple manner which borders on impressionism in sculpture. The bronze faithfully interprets the artist's manner and his meaning, which centers in the sad, tear-dimmed eyes, whose gaze wanders toward the land of orange blossoms. "Light Pursuing Darkness," is a high relief tablet by Dalou, finished and chiseled in a masterly manner by Albert Rose, the chief of the practical department in the Susse establishment. "The Return of Spring," by Mathurin Moreau, is a dainty subject appropriately executed. One of the reproductions was that of the "Secret of the Tomb," by Saint-Marceaux, one of the triumphs of modern French sculpture. A bronze edition of this powerful work fully conveys the spirit of the original, the flesh being treated in a manner calculated to put in relief the firmness of the guarding genius and the robust elegance of his figure. Among the works of somewhat earlier date the "Chanzy" monument, usually called "The Defense of the Flag," was to be seen. This beautiful group of soldiers and marines might be studied with profit by "art committees" called together to choose "figures" for soldiers' monuments in this country. "Orpheus and Eurydice," by

Auguste Paris, is a fine group, and "Time and Song," a totally different subject, shows the versatility of the sculptor and the technical resources of his interpreters. "Young Molière," of Gaudez, and "St. John," of Lafrance, were also to be seen, as well as many no less important subjects and groups showing the same careful and sober treatment of bronze and high artistic results. Some very good gilt bronze candelabras were also exhibited. The designs by Lelièvre and Robert Brothers were in the inevitable Louis XV style, but full of the marked individuality of the designers. The workmanship was of course highly satisfactory.

Pinédo exhibited a large collection of fine subjects and a number of small bronzes showing high finish and pleasing combinations. The chiseling was done so as to produce the softest appearance and the patinas, without degenerating into crude polychromic effects, are yet marked enough to be called decorative in some cases. This search after effects has led certain manufacturers to doubtful results, but in Pinédo's case the productions, when they do not stand on the highest pinnacle, are always tasteful and artistic. Among the many highly meritorious pieces on exhibition may be mentioned "The Yoke," by Depin, a strong production, thoroughly good in execution. A fine bust of "Milton," by Carrier-Belleuse, chiseled with great care and giving a good idea of the style of the artist. "Beware of Wolves," by Hiolin, a spirited group. "The Ballad Singer," by Cambos, a pleasing figure well rendered in bronze. "The Fisherman's Child," by Villanis, a boy making a boat; much more natural and spirited than children usually are in statuary. The firm had a number of smaller bronzes for decoration of the household, such as fanciful vases, candelabras, inkstands, card receivers, etc., very tasteful in design and carefully finished. The silvered bronze ornaments were particularly good.

Émile Colin & Co. had a highly meritorious exhibit in art and decorative bronzes. That the firm is exacting in its requirements as to models and finish is plainly seen in its work. Among the groups on view were "The Improvisatore," by Charpentier, a man of the golden age playing on a rude flute, a very fine example of the bronze maker's art; "Mercury Carrying the Infant Bacchus," a quaint group well interpreted in metal. The decorative bronzes were of a high order of merit. An exceedingly fine lampadère, designed by Piat, was seen, representing Diana in gilt bronze, standing by a marble column, at the summit of which the lamps were poised. Another beautiful decorative piece was the white marble bust of a woman, with a gilt-bronze bodice. In this particularly pleasing work the artist had succeeded in giving to each material its proper value, thus producing a thoroughly well-balanced composition.

Fernand Gervais exhibited a variety of careful works of undoubted value, both in his art and decorative bronzes, which showed the same

conscientious regard for high workmanship and artistic finish. His chimney garnitures in gilt bronze were highly commendable, particularly the large clock with accompanying candelabras designed by Carrier-Belleuse. The female figure on the clock of white marble with gilt bronze base and ornaments; design and execution are both remarkable. Among the art bronzes exhibited by this firm was found a spirited dancing group, "Saltarella," by Mathurin Moreau, and "David," by Michel, both thoroughly commendable for elegance and finish.

In the exhibit made by Houdebine father, and son, much was to be found to which the qualification of pretty and pleasing can be applied. There were good bronzes, among which a "Watteau pastorale" by Gaudez, may be mentioned. But the firm was better represented in its decorative bronzes, such as clocks, vases, candelabra, etc. The dainty eighteenth century styles prevailed in the designs, but no fault could be found in the result. The effect produced by the blending of gilt and highly polished black bronze was particularly successful, as shown in many clocks and other objects. A fine clock by Carrier-Belleuse was noticeable, as well as a fine Louis XVI chimney garniture. A pair of Louis XV vases in colored marble adorned with gilt and black bronze, and supporting a bunch of electric lights should be mentioned. Among the small clocks, one with a black bronze cupid, on a gilt chariot, driving a black bronze dragon was conspicuous for quaintness of design.

Eugène Soleau handles ornamental bronzes in a very original manner. He uses gilt, silvered, and other bronzes to adorn statuettes, vases, candlesticks, lamps, card receivers, etc., and produces quaint and piquant effects by well-studied surface work calculated to emphasize the spirit of the design. He is the editor of Chéret's works, who can find no fault with the manner in which the dashing spirit of his designs is interpreted. Several of Chéret's vases were exhibited finished with a peculiar patina of coppery-red tinge with light green reflections, the effect of which is perhaps more startling than satisfactory. A little Bacchus carrying an amphora was neatly quaint in spirit and execution, and several card receivers, the bowls of which are supported by children, were imbued with a life movement not always found in such articles. A large wall electrolier by Chéret was particularly remarkable. A bunch of naked children, suspended to a nail by a ribbon which surrounded them, held aloft the electric bulbs. They were not of a sterotyped fat-angel style, but very imps of mischief, yelling, laughing, scolding as they struggled in the bonds that held them. The figures were rendered in bright gilt bronze and the ribbon in dark metal.

H. Peyrol exhibited animals only. His collection consisted mainly of Rosa and Isidore Bonheur's models. It was evident that his main care was to reproduce the spirit of the model, by no way neglecting

the technical part of the work. Some of the bulls were particularly fine. Horses, also, were well treated, and such well-known and esteemed groups as "The Winner of the Races" were on view. The exhibit was interesting in its variety of representation of animal life.

Adrian Duval had a good exhibition of artistic bronzes, which by careful finish and conscientious work compared well with the dangerous competitors which surrounded him. A few groups by Gaudez were specially noticed, among which were "The First Printers," a well known subject full of earnestness. "The Difficult Duet," a subject of less import, and "The Violin Maker," a pleasing composition. A very good "Watteau" was among the best productions.

C. E. L. Tassel's exhibit consisted largely of what may be called sporting subjects, and partly of bronzes where, in addition to the usual legitimate methods of finishing by means of smooth patinas, high colors and the gilding and silvering of various parts were used to produce decorative effects. The metal used was always bronze and not spelter or alloys, as in some other cases we will notice. Among the sporting subjects "The Fencers," by Mayer, were on exhibition, a rather well-treated bronze, but the design of which falls below the level of high art. "The Foot Race," four runners reaching the goal, is in the same category and subject to the same criticism. The decorated bronzes reached a higher level, and the "Arab Armorer" and the "Arab Sentinel," of Peynot, were good examples of coloration remaining strictly within the boundaries of good taste.

Coupier & Drouart had an exhibition which, on account of the novelty of the effects produced and the cheapness of some of their productions, deservedly attracted considerable attention. This firm makes real and imitation bronzes, but treats the latter in such a finished manner that, when the patina has been applied, it is impossible to distinguish the bronze from the spelter. Several of their subjects were reproduced in the two metals, and differences were hard to detect, except in the price. Polychromy was not resorted to catch the popular eye; well-studied patinas were the only recourse and the result was always artistic. The most used of these with this firm was of a pleasing green-gray color, fitting equally well real bronze and zinc compositions. Among the good bronzes was the "Numquam Desperandum," of Grégorie; a "Diana," of Roland, in both metals; "Spring," of Moreau, transformed into an elegant electric-light bearer; a "Mercury," of Bouret, in spelter, but finished with the care usually bestowed on bronze. There were also candelabra, vases, chandeliers, chimney garnitures, etc., in gilt bronze of good design and workmanship. A mirror frame was particularly good, and two large candelabra supported by caryatides were conspicuous for artistic aspect though made of a cheap metal.

Hottot & Charpentier had a large exhibit, made up entirely of highly decorated zinc groups and figures, the appearance of which was more

startling than strictly artistic. Shining patinas and bright colors were used to produce pronounced decorative effects, the subjects being usually chosen among Eastern nations, so as to give a reasonable pretext for laying on the pigments. Though it would scarcely be proper to classify this kind of wares among the works of art, it is evident that the manufacturers know how to remain within proper bounds and never allow their productions to suggest the grotesque, in which some of their less intelligent imitators easily fall. Hottot's figures, in spite of the patent effort at high decoration, are always well modeled and never in the least offensive to taste.

The exhibit of E. Blot consisted also of composition groups and figures more or less highly colored. The colors, however, were always subdued and patinas of queer hues were used, the effect of which was not unpleasant nor in bad taste. A bust of "Sapho," by Villanis, colored in pale tints in imitation of Greek sculpture, was pleasing. Some rather realistic busts of young women, by Nelson, finished in light green patina, had a quiet decorative effect, and various fancy subjects, like "A Young Girl Sitting on the Crescent Moon," by Van der Stracten, might find favor even with the most fastidious.

Bouquet had an exhibition made up almost entirely of busts of women. The material was spelter tinted in colors so as to produce the most startling realistic effects. The flesh was a pinkish yellow; the lips, hair, and eyebrows were treated in pale, natural colors, while the eyes, by exaggerating the depth of the eye-ball cavity, were imbued with a strange naturalness. Exceeding cleverness on the part of the manufacturers placed a certain artistic stamp heir products, but it was art gone mad.

A. Rollet manufactures fancy articles, such as lamps and stands, vases, small tables, jardinieres, chandeliers with gas and electricity, ash and card receivers, etc. His material is what he calls a tin alloy (in reality mostly zinc), which he works in all sorts of fearful and wonderful shapes. Storks, leaves, flowers, butterflies are made use of and painted all the colors of the rainbow. This ware should fill a want and attain popularity among certain classes of society. One thing in its favor, the workmanship is remarkably good.

Millet exhibited copies of eighteenth century furniture in which gilt bronze played an important part. There were also clocks, mirror frames, etc., of the same period, the originals being now in the Louvre or other national museums in France. These copies are marvels of fidelity to the original conceptions, and, though mere reproductions, acquire, by the thoroughly conscientious and artistic manner in which they are executed, a value of their own. The bronzes were a perfection in workmanship.

A. Beurdeley had a similar exhibit where numerous examples of old furniture were shown. The same care was noticeable throughout the entire collection. A copy of Louis XV's desk, now at the Louvre,

was conspicuous, as well as the large clock, by Jacques Caffiéry, now at Versailles. Among the modern creations was a Louis XV mantelpiece and chimney garniture, models of taste and perfect workmanship, also a large Louis XV mottled celadon vase with bronze mountings. These were made for an American palatial home.

Gagneau manufactures all sorts of apparatus for lighting. His exhibit consisted of exceedingly artistic and decorative pieces, excellent in design and workmanship. The difficulties in the way of blending art with the practical necessities of the case were thoroughly overcome, and the results were highly satisfactory. A large Louis XV decorative vase, designed by E. Piat, in dark marble with gilt bronze ornament, holding a bunch of lights, was noticeable for taste; also a tripod lamp stand, which, though inspired by Louis XV style, bears a decided modern stamp which Piat has impressed upon it. There were several pretty silvered-bronze lamps and some vases by Levillain, good specimens of his genius as a designer. A number of highly decorative chandeliers were shown, among which those designed for electric lighting were particularly interesting. An attempt had been made to soften the harsh electric gleam by screening the bulb by means of softly tinted crystals, sometimes in the form of articulated flowers.

P. Borgest exhibited a collection of hanging and wall lamps of brass and iron, mostly in Persian style. The designs were cleverly applied to Western uses, and in workmanship the imitation easily surpassed the genuine articles.

Louchet Brothers had a very original exhibit of decorative pieces made of porcelain and gilt bronze. There were vases of all sizes, household ornaments, large and small, where painted porcelain and onyx were blended to bronze to produce the desired effects. The most striking feature of this exhibit was the evident determination of the designers to get away from the prevailing strict styles. The designs are eclectic in the broader sense of the word. The result is not always satisfactory to an eye trained in the tradition, but, even if so, the firm must be credited with a great deal of courage to thus dare to brave the schools. The workmanship is not of the highest order, but sufficiently good to produce the decorative effects sought after.

Christolfe & Co. had a remarkable exhibit in the electricity building. It consisted of a variety of objects obtained by electro-deposition of metals in molds. It is well known that this firm was a pioneer in the employment of electric methods for ornamental and artistic metal work. The high results obtained, as shown in Chicago, are evidences that the superiority acquired is still retained and progress is constantly being made. This branch of industry, as developed by Christolfe & Co., has an important bearing, not only on industry, but on art education as well, since it allows the most faithful reproduc-

tion of any work of art in metal at a cost which puts it within the reach of the poorest art school. The industrial examples consisted mainly of solid bronze moldings and ornaments for decorative purposes in making furniture. Statuettes in one piece by a deposition of metal in gutta-percha molds were shown, with outward effects obtained by a deposit of other metals upon the surface. Many fine reproductions from the Louvre Museum were on view, as well as some pieces from the Hildesheim treasure. Two large bronze trophies from the Versailles Palace adorned the sides of the cases. The Henri II armor, from the Louvre, was conspicuous. It was of copper electro-deposited in the mold and covered with electro-deposited iron, thus giving an exact reproduction of the original. The possibilities of this process were shown in large photographs of the work executed by the firm, such as the large groups, over 16 feet high, from the opera house in Paris; a statue of the Virgin at Notre Dame de le Garde, Marseilles, nearly 30 feet high, and the bronze gates of the Church of St. Augustin.

The Val d'Osne Company had an interesting exhibit of cast-iron statues and animals chosen from the large collection for which this company is celebrated. They were mostly reproductions from the antique, with such modern additions as may be used for the ornamentation of gardens, lawns, fountains, etc. The subjects were cast with unusual care, the result being highly satisfactory when the uses they are meant for are taken into consideration. Many of the statues and groups were bronzed by electrical means. The iron surface was first carefully finished and the bronze applied and finally treated like real bronze. The effect was very good, the possibilities of the process being best exemplified in a very good Drinking Faun, by M. Moreau, placed in one of the alleys of the French section.

Bricard Brothers, of Paris, had an exceedingly interesting collection, consisting of artistic hardware. There were locks, knobs, bolts, door knockers, door handles, window fasteners, etc., all made in the most artistic form and mostly in the eighteenth century style. Some of the pieces were gems, both as to design and workmanship. The metal employed was chiefly a light gilt bronze, and the chisel work was done as carefully as in the best art bronzes.

The art metal workers of Austria, though not represented in large numbers, may well be proud of the display they made at the Columbian Exposition. The works they exhibited showed that their efforts in retaining the excellent reputation they had gained were successful. They seemed to suffer from the lack of good statuary models, and with the best of them the workmanship is usually more interesting than the subject. In purely decorative bronzes the styles are still adhered to to a considerable extent, with more or less success as to design; but they are not exclusively followed, as in France. In many instances the tradition has been flung aside and an original style of

decoration, widely different from that of the past centuries, has been adopted. It is particularly noticeable in what is known as "Vienna articles," where the fancy of the designer roams at will, in total disregard of what has been done before in other countries. The same spirit of independence is extended to more important decorative pieces, and although it can not be justly said that the effort is successful in all cases, these creations are rarely in bad taste. The workmanship is usually of a high order, brilliant surface effects being sought after.

J. Kalmar had a very fine exhibit of varied subjects, bearing the stamp of conscientious effort toward perfection in artistic manufacture. The chiseling showed a delicacy of touch which bordered on overrefinement, especially in the figure work. Surface effect was studied with care, and the many patinas used in finishing brought to mind some of the Japanese work in that line. Exquisite as the workmanship was, an improvement might be suggested in the direction of breadth of treatment. All the art bronzes shown were more remarkable for the workmanship than the models. Two companion pieces, "The Sower" and "The Mower," by Prof. A. Kühne, of a rather academical turn, were finely chiseled and finished. "Mercury" was treated in a peculiar manner; the surface had been left unpolished and the mark of an exceedingly fine tool was plainly visible on inspection. The effect was novel in so small a bronze. A nymph, "Echo," by Cuglierero, a study of the female form, was almost too skillfully treated. The fine and smooth dark patina had a peculiar tinge, which differentiated it from the common dark finish used in treating small bronze reproductions of the antique; but such overrefined touches as the microscopical chisel marks in the folds of the skin, though proofs of the cleverness of the workman, can scarcely be said to add any artistic value to his work. "A Bather," a hackneyed subject, was finished in the same superfine manner. Among the decorative bronzes were found several very interesting pieces. The clocks and candelabras showed invention in design and excellent workmanship. A vase decorated with a Satyr's head in gilt bronze among silvered leaves was a good example in the special Viennese style. A pair of gilt bronze medallions in low-relief, "Day" and "Night," were particularly fine, the chisel work being excellent in every respect.

D. Hollenbach's nephews' exhibition consisted mainly of decorative bronzes and gilt bronze and some statuettes, small reproductions from the antique mostly. A pair of large bronze candelabra made up of five boys forming a pyramid was conspicuous. The design was rather heavy, but the workmanship was good. A good renaissance clock and accompanying candelabra was seen. The chisel work on the gilt bronze was more than fair. The statuettes were well finished in the usual black and green tints. There was also a satisfactory collection of inkstands, candlesticks, etc., in gilt and green bronzes.

Dziedzinski & Hanush exhibited decorative and household bronzes

which showed careful workmanship. A group consisting of a boy holding a clock in suspension was very well treated. A number of small pieces, such as clocks and candlesticks, inkstands, card receivers, caskets, etc., mostly in eighteenth century style, were finely executed.

C. Lux's exhibit consisted entirely of what is known as "Vienna articles." It was remarkable from the fact that the designs were all in the peculiar manner which has been developed in Vienna, a manner which, as yet, seems to have no laws but the fancy of the artist and the avoidance of any of the accepted forms. It is a little early to dignify it by the name of style, for no important work has yet been evolved by this school of ornamentists, and their efforts have been confined to the narrow limits of decorative household articles, such as those under discussion. It can not be denied, however, that many of the creations are pleasing, though it is more through quaintness than dignity. The objects exhibited by C. Lux were executed with a great deal of care, and even the least important of them were treated as conscientiously as the largest. There were several gilt bronzes and also patinas of all colors, including a dark green, the effect of which was very rich. There were clocks and candelabra of fantastic shapes, inkstands, blotters, paper cutters, card receivers, etc.; in fact, the whole range of such ornamental articles.

Pick & Fleischner exhibited some very good "Vienna articles," to which the above remark may in a measure be applied.

B. Heller & Sons' exhibit consisted mostly of office supplies, such as inkstands, blotters, paper cutters, receivers, etc. These objects were made of bronze in rather simple designs, but conscientiously manufactured. There was no pretension to high art, the aim seemingly being to produce a well-made ornamental article of commerce.

The part of Victor Stiassny's exhibit that came within class 585 was made up of furniture of the most fantastic description. It was a blending of porcelain and gilt bronze with a dash of plush here and there. The ornaments were of the ultra rocaille family, and the shade of Just Aurèle Meissonier, the father of the baroque, must have started with joy if it came within sight of this exhibit. But it must be noted that the work was very well done and that there was about the articles a certain dash and splendor that go far to warrant any popularity which they may have.

Prof. Otto König had two small symbolical groups, "Wine" and "Water," in light bronze. The chiseling was somewhat overdone, and the smooth figures lost in life thereby.

It is a pleasure to record the achievements of Carl Waschmann in his particular line. He exhibited 4 frames, in which he gathered 23 subjects in repoussé and chiseled silver, which for beauty of finish and general effect had nothing to fear from comparison with

any object in the manufactures building. The designs were not original, but mostly reproductions of paintings. That the artist chiseler entered fully into the spirit of the subject was evident, for no detail, whether in flower, landscape, or human expression, had been neglected, and by a clever use of high and low relief the effect of distance was presented in a marvelously striking manner. The plates were small, the largest scarcely 6 by 8 inches, yet the original expressions of the faces were faithfully kept, as well as all details of dress, hair, etc. A couple of "Lions Creeping Over Rocks" were beautifully rendered. A "Wreath of Roses" was a marvel of patience. A "Ballet Girl" in her fluffy skirts was thoroughly well expressed. "La Descente de la Courtille" of Moreau was reproduced, a difficult task on account of the diversity of the many figures. A Watteau scene, with an appropriate elaborate repoussé frame, was exceedingly remarkable for the delicate, yet firm, manner in which the original was reproduced. Each piece was a gem and the ne plus ultra of chisel and repoussé work in silver.

The German Empire was represented by a great number of exhibitors, though comparatively few of them restricted their productions to real bronze. With the exception of some of the smaller exhibits, where bronze was employed and careful, artistic treatment was noticeable, a great portion of the objects on view were made of zinc or composition finished to imitate bronze. The inevitable result was a lowering in the average grade of the collection, which became very obvious in some individual exhibits. There were remarkable examples of difficult metal casting, and in some of the smaller pieces equally remarkable cases of high artistic finish. The exhibits in group 93, class 585, had a large variety of objects from bronze statues to beaten copper ware. For reasons yet to be explained, quite a number of exhibitors were transferred from group 93 to group 96. As their works were in all points similar to others classified in group 93, they will be reviewed here, proper notice of the classification being given. The decorative and pseudo bronze manufacturers had a large collective exhibit, which, unfortunately, was so located that artificial lighting had to be resorted to continuously. The objects on exhibition at that point consisted mainly of household ornaments, such as clocks, candelabra, caskets, salvers, inkstands, etc. The style adopted throughout was an attenuated eighteenth century, of little value from an artistic standpoint. The forms were generally stunted and meager, and the materials employed of common grade. The finish was gaudy and the workmanship not entirely satisfactory. In fact, it was plain to see that the chief effort was to produce a cheap and showy article to meet the demands of not too fastidious customers. Fortunately there were shining exceptions to this general rule of indifferent value. We will call attention to them further on. Taking the exhibit in this group and class as a whole, it was irregular in quality. There were

some pieces worthy of the highest praise, but, especially among the decorative bronzes, the evident desire, or perhaps the necessity, to lower the price of the article had had a deteriorating influence on the wares produced, both as to the design and workmanship.

The well-known firm of H. Gladenbeck & Son, Friedrichshagen, near Berlin, made a very creditable display of metal statuary. There were a large number of well-chosen models, which in a good light would have attracted more attention. Unfortunately, the collection was placed in a dark niche, where inspection was difficult. Taking it as a whole, the exhibit was good. The workmanship, though not always of the highest order, was satisfactory, even when cheaper metals, of which liberal use was made, had been used in casting the figure. This firm exhibited two large pieces, on each side of the main court, which showed remarkable skill in casting metal. They were a "Centaur Carrying a Young Woman" and "An Ancient German Sliding Down the Alps on His Shield," both by Begas. This last group especially presented great difficulties to the founder on account of high projections and undercut parts, which a cire-perdue mold would seem at first to be the only way to solve. The material was zinc, bronzed over. In the niche the sensational "Messenger from Marathon," by Krüse, was conspicuous. A good representation of an ancient statue found in the Tiber, called "The Praying Boy," was seen. A very good "Archer," by Professor Uphus, was well finished. There was also a fine group, "Rhinegold," by Bernewitz, consisting of two Rhine daughters holding aloft a lump of tempting gold. Among the larger pieces "Spring," by Stark, and a "Ropeskipper," by Zadow, were noticed. The firm had on view the well-known group "Rescued," by Brütt, representing an old sailor bringing a young woman bather out of the water. There was a sameness in the manner of finishing the work on exhibition, both as to color and chiseling, which made the average effect rather monotonous. The impression conveyed was that the work was done conscientiously but not brilliantly. A number of small pieces, mostly reproductions from the antique, were treated in a rather effective smooth, black manner. Among the best modern examples in this class was a "Bathing Girl," by Eberlein, conspicuous for a faithful expression of the first shock given by the contact of cold water with the feet.

Paul Stotz, of Stuttgart, occupied another dark niche, where his best productions were seen in the half light not calculated to show them to good advantage. In this niche were placed the best pieces exhibited by this house, while an alcove under the gallery had been reserved for more common wares. There was a wide difference between the two exhibits, the one in the niche presenting pieces worthy of praise for design, workmanship, and choice of materials, while the other contained an assortment of showy art objects, so called, the most conspicuous quality of which was cheapness. In the niche a set of

altar candlesticks and a large baptismal font were conspicuous. The design was rather heavy, but the work on the gilt bronze was good. A well-studied three-quarter sized figure of an "Angel Bearing Palms" in light bronze was very well executed, its surface being conscientiously chiseled and finished throughout; two life-size bronze busts of a "Faun" and a "Bacchante," in which life and animation were broadly rendered in a satisfactory manner. In the alcove were placed a variety of objects, such as gas and oil lamps, candelabra, candlesticks, inkstands, blotters, statuettes, etc. The lamps and candelabra were made of majolica and varnished bronze, but bronze zinc replaced the real metal. The designs and workmanship were fair for such wares, which were undoubtedly meant for buyers whose fortune is limited and artistic taste not too critical.

The Bavarian Bronze Factory, of Nuremberg, had a small exhibit of bronze busts and statuettes, mostly reductions from the antique or the renaissance. The work was carefully done. This firm also exhibited some small aluminum ornamental castings, for card receivers, trays, etc.

Pirner and Franz, of Dresden, brought a collection of small bronze animals. The metal was well treated, and some of the subjects, especially the dogs, showed a good amount of life for the small size of the pieces. The chisel work was good.

Professor Wiedeman, of Berlin, exhibited a well-fed "Judith Holding the Head of Holofernes;" Kehr and Palm, of Nuremberg, had a careful reproduction of Vischer's fine "Archer," in the Nuremberg Museum, and Aloie Stehle, of Munich, sent a very good small cire-perdue statuette of a Japanese dancing girl.

Cosmos Leyrer, of Munich, had a remarkable exhibition of small bronze objects, requiring great skill as well as artistic taste. There were dainty wreaths of palms and flowers made of assembled pieces requiring the greatest care in handling. "A Warrior," scarcely 18 inches high, was fully armed and equipped with detachable helmet and breastplate, under which a coat of mail was visible. The surface of the armor was finely engraved. A small relic or jewel holder was fitted with doors and compartments, requiring most accurate workmanship. The outside was finely engraved and inlaid. Personal ornaments, such as brooches, pins, etc., of carved and oxidized silver, showed artistic merit of the highest order.

Arndt & Marcus, of Berlin, were easy leaders among the manufacturers of ornamental articles in which metal played the most important part. This firm had a large and varied exhibit, consisting entirely of articles for household decoration, such as lamps and lamp stands, vases, candelabra, pedestals, card receivers, trays, caskets, inkstands, etc. The materials used were carefully chosen and spelter generally set aside. The workmanship was in all cases highly commendable. In all bronze work, as in statuettes, receivers, etc., the finish

was excellent, and silvered and gilt bronzes were treated in the most satisfactory manner. The designs were mostly inspired by eighteenth century models, treated in the rather heavy manner which characterizes German adaptations of this style, but the compositions were always pleasing. Some ornamental lamp brackets were noticeable, and particularly a remarkable vase on a column pedestal ornamented with silvered and gilt bronze, the general effect of which was charming.

Otto Shultz, of Berlin, made an excellent display of ornamental articles, in which majolica and varnished bronze entered largely. He also had quite a variety of the usual house ornaments, such as statuettes, candelabra, card receivers, etc. The metal used was mostly zinc, but the surface was treated with so much care and skill that the fact was overlooked. The designs were perhaps more likely to please popular taste than superfine critics, but the aim was evidently to produce not priceless artistic wares, but a good article at as low a price as possible. The effort was apparently successful, which is no mean praise for the firm.

W. Quehl, of Berlin, exhibited quite a number of clocks, candelabra, candlesticks, and metal ornaments, mostly in the "bombé" style with ormolu ornaments. The designs were rather meager and lacked the vigor which the style needs to make it quite acceptable. The work was very fair, though it was apparent that the desire to bring the price within certain limits had had a deleterious influence on the results.

This last criticism may be applied to all the remaining exhibitors in this collective exhibit of ornamental ware. The metal work is thinned down to a limit which the eighteenth century styles they generally follow can not allow without serious detriment to the general appearance. The designs lack study and the workmanship is at best only fair. Chisel work is neglected or entirely lacking; metal is simply cleaned, gilded, and varnished. The effort is entirely toward producing a commercial article having artistic pretensions, but within the reach of persons of moderate means. The solution of the problem implies a neglect of some of the essentials in art, but not by any means entire failure.

Among the exhibitors of these ornamental wares may be mentioned Gustave Grohe, of Berlin, who exhibited some lamps and vases of majolica and gilt bronze. He also had electro silvered photograph and mirror frames, candlesticks, caskets, and other trinkets. Emil Krohne, of Berlin, had quite a display of majolica and gilt bronze chimney garnitures in a thin Louis XV style. The objects on view were good examples of what might be called commercial artistic manufacture. H. Wolf, and Peartree & Co., of Berlin, exhibited vases, candelabra, etc., of majolica and varnished bronze. C. Rakenius & Co., of Berlin, had an exhibit consisting of lamps and largely of statuettes and small animals cast in zinc and bronzed over in the ordinary

manner. Eisenwerke Gaggenau, of Gaggenau, had a very large characteristic exhibit of factory-made ornamental objects. The wares were various. There were small animals, lamps, vases, flower stands, barometers, inkstands, card receivers, paper weights, etc., manufactured in the cheapest manner and of the cheapest materials. The results, as far as prices were concerned, were astonishing; from an artistic standpoint, they were appalling. But articles of this grade evidently fill a need and, on the whole, the firm is to be praised for the results achieved.

Passing on now to a class of ornamental articles more essentially German, we find the exhibit of H. Seitz, of Munich, consisting of embossed and beaten copper vessels. There were large jardinieres and flower pots, basins and water pitchers, flagons and beer mugs, wall panels, trays, dishes, etc., of various shapes and adorned with pleasing embossed designs. Shapes and ornaments were inspired by the best models of old German art and were no less satisfactory than the workmanship, which was of a high order. The surface of the objects was treated in various manners so as to produce different colors, such as copper might assume by age or exposure. Everything about this exhibit was in perfect taste.

T. Winhart, of Munich, had a similar exhibit to which the same remarks apply in a measure.

F. H. Kusterer, of Augsburg, and Schöne and Müller, Dresden, had less important displays of the same sort of wares.

T. C. Spinn, of Berlin, furnished gas and electric chandeliers for several room exhibits and for the chapel in the German Government house. The examples shown were well designed and conscientiously executed; they were plain evidence that this firm had succeeded in raising the manufacture of gas fixtures to a high level.

The remaining exhibitors to be noticed in this report were classified in group 96, class 601. The number of pieces exhibited by each individual was limited, but they generally reached a high standard of excellence as artistic manufactures. Indeed, in some cases the results attained were purely artistic.

Joseph Wind, of Munich, had the two diminutive cire perdue figures of little girls, good in expression and well executed.

Fried Kuhne, of Munich, sent a small pair of figures, an "Incroyable" and "Merveilleuse," rather hackneyed subjects, but carefully cast in cire perdue molds and well finished as to details.

L. Barillot, of Berlin, had a number of very small figures remarkable for careful chisel work. The clever handicraft spent in finishing them was worthy of more interesting subjects.

George Rasmussen, of Berlin, exhibited a collection of fine medallions, showing a thorough acquaintance with the art of metal chiseling. There was a particularly good head of Bismarck, with chased frame surrounding it.

Otto Rasmussen, of Berlin, contributed a lot of very good small animals in bronze. The finish both as to chiseling and surface coloring were highly satisfactory, and the animals showed more life than usually found in such small objects.

Otto Rohloff, of Berlin, had an exhibit of small ornamental pieces, such as candlesticks, inkstands, etc., of lapis lazuli and gilt bronze, silver drinking cups adorned with repoussé designs, and some portraits in relief. The latter were the best part of the collection, the other pieces being very fair but somewhat coarsely chiseled.

Adolf Thomas, of Berlin, had some nicely finished bronze pieces, the best among which was a large tray with hunting dogs chiseled in relief.

In the niche, where the festival presents to Friedrich of Baden were placed, Fritz Siedle, of Karlsruhe, exhibited an exceedingly fine group, a pyramidal nautical conception with sea horses as a base, upon which are mounted a dolphin carrying a sea god, who in his turn carries aloft a nautilus shell. This is a most graceful composition, full of artistic spirit from base to top. The treatment of metal, silver, and gilt is remarkably good; it is the work of a true artist.

In the same niche we find a bronze panel of Götz and Mayer, the subject of which is a medallion of Friedrich of Baden surrounded by appropriate emblems. In design and execution this work is remarkable, and must take rank among the finest pieces of the sort in the manufactures building.

Italy was represented by a number of her best bronze founders, whose exhibits were largely made up of reproductions from the antique and the Renaissance periods. These copies were somewhat coarse in execution, probably to conform more closely to the original old bronzes; but in some instances the same models were scraped and polished till the life and meaning of the original were entirely lost. Some modern works were shown, but they were generally of little importance, consisting mainly of genre subjects taken from paintings, a practice that can never result in anything entirely satisfactory from an artistic standpoint. Sculpture should not take its inspiration at second hand. The workmanship in these subjects was careful, but it is clear that in the treatment of bronze surfaces, both as to patinas and chiseling, the Italian founders are not extending the field of their efforts. They have fallen into certain habits of manipulation from which they do not seem to vary.

Antonio Pandiani, of Milan, had a large exhibit of bronzes, consisting mostly of reproductions from the Renaissance period. The pieces were faithful and conscientious copies, and carefully reproduced the color and finish of the originals. Among the many pieces may be mentioned two "Davids," one by Verocchio, the other by Donatello; two sets of large candelabra from Pavia; a large vase from the Vatican; two chandeliers from the Farnese Gallery; a

collection of alto relievos after Donatello and others, and some minor objects after Cellini. The firm presented many examples of modern work, a few having been made expressly for the Columbian Exposition, among which were the ever-recurring bust of Columbus, two sulver cuppe "Sport," a group representing an episode of the siege of Lille, a series of alto-rilievos of "Music" and "A Happy Family," and two good candelabra for electric light. Among the older works were found a quantity of groups and statuettes taken mostly from well-known paintings. The result was not always satisfactory, as in most cases artistic expression had been sacrificed to trivial details of dress, which require more dexterity of hand than real taste. This was specially the case when silver was employed for surface finish. It served only to emphasize the faults of the composition. There were, however, some good pieces among the quantity. The following deserve mention: "Napoleon at the Bridge of Arcole," five statuettes in Directoire costumes, a "Merveilleuse at the Balcony." The best groups modeled from paintings were "The Queen's Ladies of Honor," after Gelli; "The Venetian Secret," after Favretto; "So Soon Gone," after Netzmacher; "The Old Fisherman," after Gelli.

A. Nelli, of Rome, well known for his reproduction of ancient statuary, sent good samples of his handicraft. Just outside of the Italian section were several large bronze statues, among others a Cæsar Augustus and a few gladiators, which gave a good idea of the work done by the firm. For economical reasons the statues were cast in several pieces well joined together. This is current commercial work, purely decorative, no attempt being made to produce new effects in surface treatment. The exhibition inside of the section included smaller reproductions and a few original pieces. The latter consisted of a few small cire perdue groups, of which little more can be said than that they were successfully cast. The former included reductions of many of the usual antique subjects, such as the "Thorn Extractor," "The Vatican Mercury," "Apollo Belvedere," "The Milo Venus," etc. The patinas were varied and constantly satisfactory, but in most cases the chiseling was overdone and the pieces too smooth and lifeless. There were also several fair candelabra in light and dark bronze where the chisel work was done more intelligently.

B. Boschetti, of Rome, had various reproductions from the antique, as well as vases, candelabra, etc. The gilt-bronze work in the decorative pieces was done with a light and pleasing touch. The larger pieces of statuary, usually in highly polished light bronze, were too smooth to reflect much life. The best among them were "Julius Cæsar," "A Mercury," and "Apollo Belvedere." A modern work by Boschetti, the ever-present "Bather," was fair.

F. & G. Bottacini, of Venice, had an exhibit of the same character. A low relief head of a Madonna in gilt bronze was noticeable for the delicacy of the chisel work.

Bartholomeo Muzio & Co., of Genoa, had on exhibition several examples of cire perdue castings finely executed. The most important was "Piping Faun," a rather spirited piece, although the pose of the figure lacked originality. An assortment of good flowers, wreaths, and branches completed the exhibit.

Oreste Bartoloni, of Rome, had a collection of small objects, mostly copies of the antique, statuettes, Roman lamps, and perfumed burners. The best reproduction was a reduction of Cellini's "Perseus." The green patina, Pompeian, so called, was used throughout.

G. Testori, of Turin, brought small bronze objects, such as candelabra, picture and mirror frames, caskets, small animals, etc. The workmanship was good for that class of commercial wares.

Frederico Layet, of Venice, exhibited a large bust of King Humbert. It was a very good piece of bronze casting, the surface finish being carefully done and the very dark green patina quite effective.

Russia sustained her reputation as a producer of art bronzes by sending a well-chosen collection of her small groups, representing life in Russia and its frontier countries. It is too late to offer a criticism or even a description of these remarkable creations of Russian artists in their special field. Their best pieces have become classic and are familiar to all; it might even be said that they have done yeoman's service long enough and are becoming slightly monotonous. Another Lanceray is needed to give a new impulse to an art which now seems to halt on its way onward.

N. Stange, of St. Petersburg, exhibited a large portion of the famous Lanceray collection of small bronzes. All the best pieces were to be seen, and it was pleasant to note that, although the master has long been dead, his works were reproduced in such a satisfactory manner. Among the best groups the following were noted: "The Arab Fantasia," "Sviotoslaw Arranging his Troops," "The Cossack's Farewell," "The Cossack Standard Bearer," "The Epic Warrior," "The Sleighing Party," "After the Battle," a riderless horse; "A Georgian Caracoling," and many others.

C. F. Woerffel, of St. Petersburg, had a large display of small bronze groups, depicting Russian manners and animals which the artists had successfully imbued with an amount of life quite wonderful, if we consider the size of the objects. There was a breadth of interpretation which raised them out of the mere ornamental class to a high plane of artistic value. Bears, dogs, wolves, oxen were used as models, as well as horses. Among these many groups the following were noticeable: "A Wolf Hound and Fox," "A Running Dog and Hare," "A Bull," by A. Ober; "Wolf Hounds Catching a Wolf with Hunter Following on Horseback," "A Group of Bears," by Liberich; "A Woman Riding on an Ox Cart with Man Leading Oxen," by Posen. Among the larger pieces was "Cupid and Psyche," by Professor Laveretzi, a graceful composition, well executed in bronze.

A fact noticeable in the small bronzes is that they are scarcely retouched by the chisel; the metal runs freely and comes out of the mold showing all the details. In addition to these art bronzes, the firm exhibited some very good decorative bronzes for candelabra, vases, and mountings for tables, and other objects made of semi-precious stones, like lapis lazuli, jasper, jade, malachite, etc. The designs were rather heavy, but displayed considerable individuality. The workmanship on all gilded bronzes was highly meritorious and showed that the firm aimed higher than at mere commercial production.

M. I. Mikeshin, of St. Petersburg, exhibited a small model of the Monument to Catherine in St. Petersburg. The reduction was done with care, and the finish was perfect.

Belgium had but one exhibitor in this group, La Compagnie des Bronzes, of Brussels, who sent a few interesting pieces. They were all cast in cire perdue molds and showed a thorough knowledge of the bronze founder's art. The "piece de résistance" from the artificer's standpoint was a large vase said to be in Japanese style, though this would be true only if Japanese stood for nondescript. It was a most difficult piece to cast, owing to high and thin projecting parts and the intricacy of such things as the handles, for instance. The surface was finished with patinas of many colors, rather dull in effect. This vase was a "tour de force" pure and simple and, as such, quite remarkable. Far more interesting were the few wreaths of leaves and flowers, firm in design, yet delicate in general effect. A large and rather theatrical "Leonidas" was given a place of honor, and Carrier-Belleuse's group of "Innocence" was conspicuous. This last group, in the artist's usual manner, was perhaps a little too harshly treated to suit the subject and style.

Sweden had but a few exhibitors in this group, but one of them, H. C. Norrstrom, of Stockholm, made a remarkable display of artistic furniture in which niello work and engraved steel held an important place. There were cabinets and tables and also vases and shields, mostly in the renaissance style. The panels were of steel, embellished with vigorous designs engraved in a masterly way. Every piece on exhibition betrayed that the maker was an artist possessing taste and skill of the highest order.

The Husgvarna Arms Company, of Jonkiping, exhibited facsimiles of ancient armors, and Berhardt Beskow, of Gothenburg, had a very large but not particularly interesting steel shield, around which various historical scenes were engraved.

In the Denmark section the most interesting exhibit in the class was that of a woman, Miss Dagmar Birk, of Copenhagen. It consisted of engraved copper ware. Although all the objects were mere household utensils, such as dishes, trays, waterpots, candlesticks, etc., the strictly correct Norse spirit with which the designs were imbued raised them almost, if not quite, to the level of art produc-

tions. The shapes were Scandinavian and nothing else, and the engraved borders and centers showed how interesting the Norse decorative motifs become in clever hands.

Lauritz Rasmussen, of Copenhagen, exhibited a few art bronzes of no great value. A "Panther Hunter" by Jerichau, and a medallion of H. S. Andersen, were the most conspicuous pieces.

Mexico sent a few unimportant pieces exhibited by the Mexican Artistic Foundry, of Mexico, and F. Carmendente, of the same place, a circ perdue leaf crown.

The Argentine Republic had but one exhibitor, Santiago Lauer, of Buenos Ayres, but his work was a surprise. He had two rather large animal groups, and a group of heads, "A Tribe Chief and his Dying Bride," which, for treatment and finish, should be placed on a level with some of the best pieces in the manufactures building. It was evident that this exhibitor had carefully followed the example given by the French bronze founders.

The Ottoman Empire had a representative in the manufactures building in the firm of G. A. Condsi and A. Andalaft, of Constantinople and Damascus. They exhibited an assortment of brass work, consisting of vases, trays, coffeepots, bowls, etc., engraved in the usual Eastern style. Some pieces were enameled in a rather dull and monotonous Eastern manner. The most interesting pieces were the mosque and house lamps of pierced brass. The firm exhibited some "ancient articles," which gave the impression that the workmen who made them were quite alive yet.

From India came an assortment of the well-known Benares and Cashmere brass work. This is well known for its original designs and rough workmanship. Some silver repoussé pieces were better finished.

Arseshir and Byramji, of Bombay, had both brass and silver work, and F. P. Bhumgara & Co., of the same place, had a large collection of the various kinds of brass goods that India produces commercially.

The Siamese Government sent a very interesting, though small, collection of brass and silver art ware. Although the designs breathed the same Indian spirit, there was a certain amount of originality in the articles on view, and specially more care taken in the execution than is usually found in Eastern works.

Minor contributions were sent from Mysore and Ceylon.

In spite of many abstentions, the United States exhibit was of such a character as to give a very adequate idea of the progress the art has made, and to clearly indicate wherein the manufacturers' efforts have been more successful. As might be expected from a nation so thoroughly well supplied with mechanical appliances, we find that large masses are successfully handled, and that monumental statues are produced which, from the bronze founders' standpoint, are thoroughly satisfactory. The impetus given to this kind of work by the

erection of soldiers' monuments all over the land, as well as a mania for the indiscriminate commemoration of private individuals in enduring metal, has compelled the training of a body of men whose skill can not be denied. It is not their fault that their works at times cause the beholder to regret that so much blue sky should be obstructed by such unsightly structures. The bronze founder is not responsible. The misdemeanor, in most cases, is the act of local art committees, the members of which, it is hoped, have seized the opportunity to visit the Columbian Exposition, and have profited thereby to the extent of realizing that, in order to build a successful monument, it is not sufficient to raise the money, but that a part of that money should go toward paying experts in art who know the difference between a "graven image" and a statue. Fortunately, the old spirit is fast dying out and rapid strides are made toward a better order of things, when a blending of technical and artistic skill will be the rule. The putting together of large works has been carried to a greater perfection than the finishing of small art bronzes. Praiseworthy advance has been made in that direction, but the art, owing to its peculiar requirements, is slow of development. It can not be transplanted bodily or forced like a hothouse plant. Each shop must have its traditions, the men must be trained from childhood, and, above all, the direction must be in the hands of a man, not a mere dilettante, but one acquainted with every trick of the trade. In view of the difficulties that stand in the way of success, the results achieved are remarkably good, and although there is no evidence that the regular manufacture on a line similar to that of the best French and Austrian houses has been developed, the advance in that direction proves that great progress is being made. The manufacture of electroplated zinc statuettes and decorative pieces has been greatly developed. Unfortunately, the high price of skilled and artistic labor prevents the American manufacturers from putting upon these wares the same amount of work as found in some French and German articles. When the seams have been carefully ground away and the piece rubbed smooth after being bronzed or silvered, it is ready for the market. The articles are glaringly smooth and shiny, but the price is within the reach of moderate persons, which fact gives it a "raison d'être." The most unfortunate part of this industry is the ruthless pirating of models. Nothing is sacred for the zinc statuette manufacturer. He roams through the prolific fields of European production and returns loaded with booty. The original "borrower" does not, however, remain long in single possession of his easily acquired property. No sooner has he put his reproductions on the market than a rival places the same model on sale. A cut in prices results, which finally leads to a lowering in the standard of workmanship. This state of things is not due to the manufacturer; the best of them deplore the conditions under which they work—condi-

tions which necessarily oppose and retard progress, while they render the business precarious. The fault lies in the lack of effective international laws regulating artistic property. If absolute property in a model could be secured, the incentive to work well would exist; but as this can not be done now, the results are unsatisfactory. Lighting appliances for gas, electricity, etc., which in foreign exhibits were placed in this group and class, were gathered in group 114 for the United States.

The Gorham Manufacturing Company, of New York, presented a collection of bronzes which showed in a marked degree the advance made toward artistic treatment of metal in the United States. This firm has evidently entered the field with a view to emulate the foremost European manufacturers, and, although it can not be truthfully said that the work was equal to the best, it is no exaggeration to say that it was better than a great deal found in the foreign sections. The chisel work was done intelligently and the general effect was artistic in a high degree. Among the pieces worthy of mention we find: "The Expulsion of Adam and Eve from Eden," in relief, a fine composition, by J. Massey Rhind, was well rendered in bronze; a bust of William E. Gladstone, by J. Massey Rhind, a difficult subject well handled; a bust of Cardinal Manning and one of Cardinal Newman, by M. Raggi, both good and carefully treated with the chisel; two strong heads of "Sachems," in panel, by F. A. Heller and F. Kohlhagen; a "Crucifixion," by H. H. Kitson, primitive in style and correspondingly interpreted in bronze. The most observed piece was a life-size silver statue of "Columbus," by Bartholdi. In general effect it was rather theatrical and can scarcely be ranked among the best by the same sculptor. The statue was successfully cast, although the manner of finish adopted—a uniform scattering of oxidized spots—made it a little monotonous in appearance.

Maurice J. Power, of New York, had a large and fine display of bronzes, showing a thoroughly practical knowledge of the business in hand. That some of the models were not altogether satisfactory from an artistic standpoint was not the founder's fault, who impartially employed his skill in the execution of the various compositions he was called upon to interpret. It must be said, however, that the greater portion of the models were well chosen and particularly interesting for the wide range of subjects they represented. There were large figures and small ones, medallions, reliefs, etc., simple and intricate, showing the great variety of work the founder is capable of turning out and the ease with which difficulties are conquered. It is evident that the founder is equally clever in large and small work. Monumental work in this exhibit was represented by a statue of an "Infantry Soldier," by David Richards, very fair from an artistic standpoint, and "Angels with Extended Wings," by C. Bubrel. These statues, which presented some technical difficulties, were well

executed and finished in a manner adequate to the subject in hand. Several smaller figures were shown, such as a "Praying Female Figure," a stock subject, by C. Bubrel; a good statuette of a "Confederate Soldier," by David Richards; an equestrian statuette of "Sheridan," a rather difficult piece nicely interpreted. Among the busts and heads were found two busts of "Washington," one from the life cast made by Houdon, the other by O'Donovan, a replica of the upper part of the statue of Washington at Newburg. These busts were artistically finished, as well as two heads by C. Bubrel, a "Madonna" and a "Christ," and a "Cupid," by Theodore Bauer. Conspicuous among the reliefs were two large subjects, the "Entombment" and "A Descent of the Cross," from French models of the seventeenth century. A set of four high reliefs, by Theodore Bauer, more noticeable for the difficulties offered in casting than for artistic modeling, represented the career of a Union soldier—"The Departure," "The Action," "The Wounded Prisoner," and the "Grave." "Bacchus on the Tiger" and various emblems were among the relief work on view. A large crucifix, from a model found in the Louvre, and a rather original ornate door knocker, by Bauer, close the list of the most noticeable pieces found in this exhibit.

The American Bronze Company, of Chicago, was a prolific exhibitor of American bronzes at the Columbian Exposition. It clearly demonstrated not only its ability to execute monumental work in a thoroughly satisfactory manner, but also its skill in casting difficult pieces and on finishing them in a way that left little to desire. A large number of fine examples were in view in the manufactures building, the best of them being easily the "David" of George T. Brewster. The figure, though not frankly original, was fine and well poised, and the founders had finished it in a way that showed how closely they follow their most successful European rivals. Examples of fine casting and finishing were found in a plaque of "Gambetta" and another of "Carpeau's Mother," modeled by Carpeau. A reduction of the group called "A Mortar Practice," by Levy T. Scofield, showed careful workmanship. Several life-size busts and a statue, that of Judge Knickerbocker, by L. W. Volk, were exhibited. The work on these was good, excepting in one case, that of a bust where the diagonal cloth and silk facings of the coat, as well as the newly laundried shirt front, were realistically reproduced. It was less a "tour de force" than a freak. The company exhibited several models of large monuments erected at various times, among others the queer colossal "Columbus," given by the World's Columbian Exposition to the city of Chicago, and a much better "Lincoln," by L. W. Volk, erected at Rochester, N. Y. The original models of Lincoln's face and hands, taken from life, by L. W. Volk, were on view in a case. Other examples of this company's skill in casting large work were found on the Ohio monument, in front of the Ohio State building, where the statue

of "Secretary Stanton" and "Salmon P. Chase," by Levy T. Scofield, were placed, and in the Illinois State building, where the "General Shields" of L. W. Volk had been erected. A smoothly finished bronze medallion of Mrs. Potter Palmer, by Mrs. Ella Rankin Copp, was found in the woman's building. Of all the productions of the American Bronze Company, the one which was seen the most, on account of the wide advertising it received, was the silver statue of "Justice," exhibited in the Montana mining section. The statue, by R. H. Park, which was said to have been modeled from a prize-beauty actress, added nothing to the sculptor's laurels, but was successfully cast and sufficiently well finished by the company.

The Monumental Bronze Company, of Bridgeport, Conn., and the Western White Bronze Company, of Des Moines, Iowa, had a joint exhibit of what they termed "white bronze." In reality the material was zinc, pure and simple, the surface of which had been treated so as to resemble gray granite. The greater part of the exhibit consisted of cemetery monuments of the stereotyped style and in close imitation of granite. The usual angel pointing upward was found there, as well as various trite funeral symbols; also samples of soldiers' monuments, medallions, busts, panels, etc. Unfortunately the nature of the material under treatment had been disregarded, so that the objects were meaningless. The color, a uniform dull, lifeless gray, added to the general lack of expression. Regarded merely as manufactured articles, these objects deserve no small amount of praise; they in no way resembled the usual thin and fragile zinc casting. The metal has been used generously, the corners reinforced, and the various parts put together with the evident effort to turn out a first-class job. To that extent the manufacturers are entitled to much credit. The surface was subjected to a sand blast and acquired in the process an outward structure resembling a close-grained stone. It is claimed that the surface remains unaltered.

If the small portion of the Tiffany Glass and Decorating Company's exhibit which properly belongs to the class under discussion had alone been on view, it would have sufficed to place the producers in the front rank of decorative artists. Originality is the keynote, and it extends not only to the designs which, though drawing inspiration from the past, are adapted to present needs with rare intelligence, but also to the methods of manufacture by which metal is used in conjunction with other substances in a manner at once original and effective. It is not used as the main member in the composition of decorative articles, but as an ornamental framework. In general, a filigree made of soft metal wires braided or woven, rope-like, and gilded or silvered, forms the frame or bony structure of the object, into which are set pieces of colored glass or precious and semiprecious stones, or even simple river pebbles. These elements are so artistically blended that the effect is strikingly novel and satisfactory.

The canonical candlesticks and the Altar Cross exhibited in the chapel are good examples of this kind of work and of the splendor which can be expressed by comparatively simple modes of manufacture. The top of the Baptismal Font was of the same nature, but the highest expression of this effective way of treating filigree work was found in the Sanctuary Lamp designed by J. A. Holzer. It was a wonderful achievement from any standpoint it may be viewed, artistically and technically. Two table lamps of glass and metal, one Byzantine in feeling, of dark-brown glass and metal, and the other Empire style, of mother-of-pearl glass and gilt metal, were remarkable as effective adaptations of those styles to modern requirements. The crown-shaped wall lamps in the dark room must also be mentioned as gems in the same line of artistic manufacture. An electrolier designed by Louis C. Tiffany was strikingly new in its conception. It was a conventionalized bunch of lilies made of filigree work and mother-of-pearl. The artist admirably succeeded in producing an original creation of the highest artistic value for a most practical use.

The exhibit of the Nicholas Muller Art Bronze Company consisted of decorative pieces made of electroplated zinc to imitate bronze, copper, silver, etc. There was a large variety of models, including statuettes, animals, lamps, fancy clock stands, etc. The models were mostly from European origin and the original spirit had been pretty nearly obliterated in the process of reproduction, but this branch of industry makes no claims to a high-art standard. The wares are strictly articles of commerce, and it is sufficient that they be manufactured with a certain degree of care to satisfy the purchaser. This company evidently aimed at doing as well as a not too scrupulous competition will let them. The workmanship is good, the various manners of finishing bronze are well imitated, and the desire to produce a conscientiously done article is evident throughout.

The Ansonia Clock Company had a variety of clocks, adorned with groups and statuettes, the whole in zinc, finished in imitation of bronze. The work was well done, though the natural sequence of things had been sadly interfered with in many cases by the rearranger, who, when it suited his purpose, never hesitated in splitting a group in two. Lovers who originally stood entwined were unceremoniously separated and made to stand disconsolate and alone at the opposite ends of a mantelpiece or with a clock dial between them. It must be said, however, that, whatever sins were committed from an artistic standpoint, the work of finishing was done very carefully.

BRONZES IN THE JAPANESE SECTION.

BY

Miss EMILY CRAWFORD.

BRONZES IN THE JAPANESE SECTION.

By Miss EMILY CRAWFORD.

The manufacture and use of bronze seems to have been known from the earliest times. It was used for implements of agriculture or warfare; fastenings for the blocks of stone in the ancient Greek and Roman buildings were made of bronze; Etruscan tripods, mirrors, etc., were made of bronze; Egyptian the same; in fact, however far we may go back in the history of the ages we find bronze employed both for articles of use and for the foundation of ornament, as rings, bracelets, etc.

Maxwell Somerville relates how he was present while some peasants of the Campagnia (Italy) were clearing the surface of a field filled with deeply grounded roots and aged trunks of olive trees, whose myriad lines of circling demarcation declared the cycles that had passed during their growth. In extracting the nethermost roots of one tree that had stood there seven hundred years (according to its girth) they came upon some slabs or terra-cotta tiles laid carefully together, forming a subterranean trough or chest. When the upper tiles were carefully removed various vessels with rude mythological drawings on them were found, and a vase, a mirror, and rings, all of "bronze," were discovered, with gems of paste and sard embedded in their rust and patina. "I held in my hand," he says, "one broken brick which at its fracture disclosed an imprisoned piece of bronze. By breaking with care the hard terra cotta I removed therefrom a common ring with a graven intaglio. It was probably lost from the hand of the ancient molder as he formed the brick, and so went into the kiln to be locked away by fire until the day when I brought it again to light."

The largest work ever undertaken in bronze was the famous Colossus of Rhodes, one of the seven wonders of the world, made 290 B. C., and which took twelve years in the making. This statue was 100 feet high, and was so placed on two moles at the mouth of the harbor that a vessel could pass between its feet. It was made in two parts, half at Samos, half at Epherus, then brought together. It only stood sixty-six years, when an earthquake overthrew it. It was finally destroyed by the Saracens in 672 A. D. This great statue may be taken as the direct ancestor of all the bronze figures now produced in immense quantities and in all qualities of metal.

In the Japanese section there is a reproduction of their earliest known specimen of artistic work in bronze, a "Stork Carrying a

Branch of Pine." The original was made three hundred years ago by one Kanchi. This present reproduction is made by his eleventh descendant, also a Kanchi.

There are several reproductions of ancient bronzes. The life-sized figure of a boy staggering along with a fish as large as himself in his arms is one. It represents some episode in the life of "Kintoki," who afterwards became a famous warrior. The figure of the great chancellor "Takenouchi," with the baby emperor "Ojin" in his arms. The figure of a lady in ancient court dress. These and similar reproductions are interesting to the historical student, while the splendid modern groups, such as the "long-tailed rooster on plum tree, with hen and chickens at foot," by Otake Norikuni, of Tokio; the great screen, "Dragons in a Cloud over Water," and the "Fish Rising," by Ishii, in the Tokio exhibit, manufactures building, show what perfection they have now attained in the manufacture and casting of bronze.

The Japanese are unrivaled in the production of "patina," but beyond that they have evolved a subtle beauty from the treatment of the different tones and colors of metals, a nicety of adjustment of color to the "sentiment" of the design, and above all a knowledge of proportion and line that elevates their work into quite a different rank to the ornamental bronze of any other nation. The great greenish jar, with a few simple curving lines which, few and simple as they are, make you feel the swirl of the water they represent, with here a fish disappearing in the current and there another one rising to catch some winged insect hovering above him, is an instance of a whole poem struck off at once and preserved for future ages in nearly unperishable form.

There is a great eagle, by Okazaki Sessei, in the art gallery. The massiveness and strength of the creature, his watchful pose with wings extended, ready to start the moment the prey comes in sight, the perfect finish of the feathers and curves of the wings, the "fitness" of the whole thing, make this eagle verily the "king of birds." The eagle symbolizes strength to the Japanese and is a very favorite subject with them. There are many, all different and all good, among their bronzes. The great "$10,000" eagle, by Saito, is an object that attracts the public greatly. They marvel at the patience that could work out its three thousand feathers, the hardness of the ground requiring a new tool every few strokes.

The tea-colored bronzes (vases, bowls, etc.), inlaid with other metals, gold, silver "shibuichi" and black "shakudo" in high relief, or in low relief, or in flat inlay, sometimes all in one style, sometimes in mingled styles, as in the beautiful vases where on a tea-colored ground twines an ivy in "shibuichi" and black in low relief, and at the base bloom golden chrysanthemums in flat inlay.

Another very valuable pair of bronze jars have a curious design. A sort of wrapping tied with a golden cord holds some exquisite chrys-

anthemums of gold and silver and a fine red "hiirokane," which means "the red copper by the chemical action," around the bowl of the jar, while the neck of it, over the flowers, is of a roughened bronze, apparently discolored by age, but of a very cunningly harmonized "patina" that gives the exquisite work on the flowers the highest distinction. These jars are the work of S. Ohashi, of Takaoka.

A very magnificent jar of steely bronze has the bowl portion in "Sukashi-bori" or openwork, produced by the ground being entirely cut away, leaving the design (a very fine one of dragons, etc.) to form the bowl. The neck of this vase is engraved in a geometrical pattern very finely inlaid in "shibuichi" (a kind of silver), and by its regularity and severity of line it makes a grand finish to the object, subduing what would be too rich a design if allowed to cover the whole of the vase. This is a good instance of the wonderfully refined taste of the Japanese. They are seldom guilty of "overloading." When they are it is never for themselves, but designed to satisfy the nonartistic notions of the Western nations.

To the archæologist, the reproduction of the antiques are, perhaps, the most interesting, such as the great lanterns with the clouds of smoke curling out of their pierced rims; or the "Incense Ships," or the great incense burners, which with their stands may represent a whole "myth." The groups of long-departed statesmen or warriors or ladies who played their part on the world's stage long ago. The lover of nature finds unending delight in the naturalistic rendering of the birds, beasts, and fishes, and the accuracy of observation shown in the "placing" of each. The artist is amazed at the picturesqueness of the effects; the metallurgist, surprised at the uses to which alloys are put. Every kind of art and science has been brought to bear on the production of these exquisite works. To the Japanese belongs the glory of carrying up to a higher platform a very noble metal—one whose beginning is lost in the mist of ages, and whose potentialities seem to be awaiting further development from their hands. No other country has shown the artistic aptitude—indeed, all other nations are merely repeating, more or less successfully, the ideas of the bronze workers of long ago, without by any means reaching their grandeur. Where will you find to-day any figures like those of the two Dukes in the "Medici" chapel in Florence, or gates like the "Baptisteria" gates made by Lorenzo Ghiberti, in the same city? Somehow the relation between the metal and the subject is missed, and a vast labor is expended, while the results still remain unsatisfactory.

Japan is represented by six companies here. With one exception they all send bronzes, the total amount of pieces, large and small, being nearly three thousand, and no two are exactly alike. It is a splendid exhibit, and from its immense variety it is almost impossible to decide what one likes really best, where all are so good in workmanship, so interesting in detail, and so beautiful in form, design, and color.

COLLECTIVE EXHIBIT OF THE BUREAU OF THE AMERICAN REPUBLICS.

BY

THOMAS WILSON.

COLLECTIVE EXHIBIT OF THE BUREAU OF THE AMERICAN REPUBLICS.

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1.

The Bureau of the American Republics is an institution maintained at Washington by the nineteen independent nations of the American continent. It was established upon the recommendation of the International American Conference, for the purpose of making known, particularly to the people of the United States, the resources, industries, progress, and commercial advantages of the Republics of Mexico, Central and South America. Its headquarters are at Washington, D. C., and its originator and first director was William Eleroy Curtis, who planned and carried out the present exhibit under the auspices of the Department of State. The exhibit was located in the eastern gallery of the United States Government building and consisted of maps, charts, pictures, sketches, photographs, etc., illustrating the various industries of these countries, and showing the cities, towns, monuments, portraits of the more distinguished individuals, types of the natives, costumes, and in every way illustrating the manner of life and condition of the people. The countries represented and the number of specimens belonging to their exhibits, are as follows:

The Republic of Mexico had 183 specimens, as follows:

1. President Diaz, of Mexico, in full military dress.
2. Custom-house at Vera Cruz, Mexico.
3. View of Vera Cruz, Mexico.
4. Citadel of San Juan de Ullva, Vera Cruz, Mexico.
5. San Juan de Ullua. Fortress at the harbor of Vera Cruz, Mexico.
6. Municipal building, Vera Cruz, Mexico.
7. Custom-house at Vera Cruz, Mexico.
8. Carts at a sugar mill of Vera Cruz, Mexico.
9. Hacienda, near Vera Cruz, Mexico.
10. Indian hut, near Vera Cruz, Mexico.
11. Indian women making tortillas.
13. View of volcano of Orizaba, Mexico.
14. Great mountains of America. Volcano Orizaba, Mexico.
15. Hotel and street in Orizaba, Mexico.
16. Church of San Jose de la Gracia, Orizaba, Mexico.
17. Husking coffee, Vera Cruz, Mexico.
18. Husking coffee in Vera Cruz, Mexico.

19. Mexican band.
20. Pulque plant, or Maguey (Agave Americana).
21. Maguey, or pulque plant, in flower.
22. A glass of pulque, Mexico.
23. Façade of cathedral at Puebla, Mexico.
24. Group of Mexican newsboys at play.
25. Huts and date palms in Mexico.
26. Old church in the Indian village of Ixtacalco, Mexico.
27. Rancho de la Canada, valley of Mexico.
28. View of cathedral at Puebla, Mexico.
29. Ancient town of Cholula, Mexico.
30. Toltec pyramid of Cholula, Mexico.
31. Mexican framers.
32. Mexican caballero.
33. Mexican housewives.
34. The coming generation in Mexico.
35. Specimens of organ cactus, State of Puebla, Mexico.
36. Palacio Federal, City of Mexico.
37. Mexican porker.
38. Mexican housekeeper.
39. Group of Mexican children.
40. Cathedral in City of Mexico.
41. Cathedral of Mexico.
42. Cathedral in City of Mexico.
43. Plaza mayor and cathedral, City of Mexico.
44. Plaza and church of Santo Domingo, Mexico. Scene of the ancient inquisition.
45. Garden in the valley of Mexico.
46. Young Mexican nurse.
47. Young Ganymede in Mexico.
48. Water carrier, Mexico.
49. Traveling basket maker.
50. Package express in Mexico.
51. Statue of the Fair God, the last of the Aztecs.
52. Noche Triste, the tree under which Cortez rested after he was driven from Mexico.
53. Convent and church of Churubusco, Mexico.
54. Convent and church of Churubusco, Mexico.
55. House at Coyoacan, Mexico, formerly occupied by Alvarado, the lieutenant of Cortez.
56. Social gathering in Mexico.
57. Snap shot in a market place, Mexico.
58. Famous canal of Nochistongo. Originally intended to drain the valley of Mexico.
59. Great mountains of America. View of the summit of Popocatepetl, Mexico.
60. Great mountains of America. Popocatepetl from a distance.
61. Panoramic view of the City of Mexico, with volcanoes Popocatepetl and Iztaccihuatl.
62. Sunset from Hotel Iturbide, City of Mexico.
63. Great mountains of America. Veiw of the summit of Iztaccihuatl, Mexico.
64. Volcano Iztaccihuatl, "The White Woman," near the City of Mexico.
65. Volcano of Iztaccihuatl. View from City of Mexico.
66. Mexican boys at play.
67. Study of life in Mexico.

68. Family party in a Mexican hacienda.
69. Views in Mexico.
70. Carrying leaves of the Maguey plant, Mexico.
71. Sunday at Santa Anita, Mexico.
72. Among the floating gardens of Santa Anita, Mexico.
73. Among the floating gardens of Santa Anita, Mexico.
74. Sunday at Santa Anita, Mexico.
75. Village of Santa Anita, valley of Mexico.
76. Pleasure boats at Santa Anita, Mexico.
77. Village of Iztacalco, near the City of Mexico.
78. Mexican boatmen.
79. Floating gardens of Mexico.
80. Scene on the Upper Viga, Mexico.
81. Fishermen of Lake Texcoco, Mexico.
82. National library of Mexico.
83. Water carrier in Mexico.
84. Fountain at the termination of the aqueduct, City of Mexico.
85. San Cosme aqueduct, City of Mexico.
87. Grove of Montezuma at Chapultepec, Mexico.
88. Walk of Montezuma, Chapultepec, Mexico.
89. Montezuma's tree, Chapultepec, Mexico.
90. Cypress grove of Chapultepec, Mexico.
91. View of Chapultepec from across a pulque plantation, Mexico.
92. View of Temasopa Mountain, Mexico.
93. Shrine of the patron saint of Mexico at Guadalupe.
94. Altar of the church of Guadalupe. Shrine of the patron saint of Mexico.
95. Cathedral, City of Mexico, and church of Guadalupe.
96. Shrine of the patron saint of Mexico at Guadalupe.
97. Mexican musicians.
98. A Mexican cart.
99. An old Mexican cart.
100. Where extremes meet, Mexico.
101. Mexican women washing clothes.
102. Kodak views of Mexico.
103. Home of a Mexican peon.
104. A familiar feast day scene, Mexico.
105. A study of life in Mexico.
106. Peon mother and child.
107. Bird's-eye view of Tampico and jetties of Tampico, Mexico.
108. Two Mexican ranchmen.
109. Peon picnic, Mexico.
110. Type of native Mexican farmer.
111. Mexican construction camp, Tecomovaca.
112. Four-ox team, Mexico.
113. Mexican plow, similar to those used in the days of Moses.
114. Glimpse of Guanajuato, Mexico.
115. View of the city of Guanajuato, Mexico.
116. Pulque plantation in Mexico.
117. Carreta, a Mexican cart.
118. In a coffee grove, Mexico.
119. A study in Mexican vegetation.
120. View of the city of Zacatecas, Mexico.
121. Metlac bridge, Mexico.
122. Rancho de la Canada, Mexico.

123. Carrying a skin filled with sugar water from the pulque plant, Mexico.
124. Avenue of Organ Cacti in the valley of Mexico.
125. Chair makers in Mexico.
126. Mexican parlor.
127. Broom peddler, Mexico.
128. Mexican peddler.
129. Mexican juggler.
130. Itinerant market, Mexico.
131. Indian homes in Mexico.
132. View of the city of Queretaro, Mexico.
133. Mexican plowman.
134. Railway bridge "Encarnacion," Mexico.
135. A ranchero in Mexico.
136. Ancient aqueduct at Queretaro, Mexico. Mexican Central railway train.
137. Mexican farm labor.
138. Rural militia of Mexico.
139. Mexican laundry.
140. Mexican village.
141. Hercules Cotton Mills, Mexico.
142. Cathedral at Guadalajara, Mexico.
143. Degollado Theater, Guadalajara, Mexico.
144. El Sanctuario, the fashionable church at Guadalajara, Mexico.
145. Guadalajara policemen, Mexico.
146. Indian pottery makers at Guadalajara, Mexico.
147. University at Guadalajara, Mexico.
148. Church of La Merced, Guadalajara, Mexico.
149. Exterior of a Mexican house.
150. Game of chance, Mexico.
151. Group of Mexican peons.
152. Mexican baker.
153. Indian mother and boy, Mexico.
154. Historical places in Mexico.
155. Salt works at Salinas, Mexico.
156. Market in Aguas Calientes, Mexico.
157. Principal plaza in the city of Aguas Calientes.
158. Church of San Diego, Aguas Calientes, Mexico.
159. Two Mexican haciendos (farmers).
160. Mexican barmaid.
161. Mule driver, Mexico.
162. Mexican boy.
163. Falls of Juanacatalan, Mexico.
164. Scene in the city of Victoria, Mexico.
165. View of the city of Chihuahua, Mexico.
166. Cathedral at Chihuahua, Mexico.
167. Main entrance of the cathedral at Chihuahua, and side entrance.
168. Mexican mother and child.
169. Indian woman of Mexico.
170. Home of a peon.
171. Group of natives of Tehuantepec, Mexico.
172. Natives of Tehuantepec, Mexico.
173. Family of Oaxaca Indians.
174. Young woman of Oaxaca, Mexico.
175. Indian girl, Oaxaca, Mexico.
176. Native girl in holiday costume, Oaxaca, Mexico.

177. Indian woman of Yucatan, Mexico.
178. The oldest house on the continent, Merida, Yucatan. Erected in 1549.
179. Rubber gatherer of Yucatan.
180. Belle of Yucatan.
181. A market woman of Yucatan.
182. Wood peddler in Yucatan.
183. Bread peddler.

The Republic of Guatemala had 56 specimens, as follows:

1. General Don José Maria Reyna Barrios.
2. Pier at San Jose, Guatemala.
3. Railway station, Guatemala city.
4. Railway train crossing Lake Amatitlan, Guatemala.
5. Pier at the port of Ocos, Pacific coast, Guatemala.
6. Port of Champerico, Guatemala.
7. Cathedral at Guatemala city.
8. Post-office, Guatemala city.
9. Medical school, Guatemala.
10. General view of Escuintla, Guatemala.
11. Glimpse of Guatemala city.
12. Executive palace, Guatemala.
13. National Institute for the education of teachers in Guatemala city.
14. Military prison in Guatemala.
15. Penitentiary at Guatemala.
16. Law school, Guatemala.
17. Interior of hospital at Guatemala.
18. Military hospital, Guatemala.
19. Calle Real, a street in Guatemala.
20. La Concepcion, Guatemala.
21. Merced street in Guatemala.
22. Concepcion street, Guatemala.
23. Going home from market, Guatemala.
24. Arches of the aqueduct, Guatemala.
25. Entrance to the cemetery, Guatemala.
26. Entrance to race course, Guatemala.
27. Ruins of Carmen Church, Antigua, Guatemala.
28. Cerro del Carmen, oldest church in Guatemala.
30. Ruins of St. Francis Church at Antigua, Guatemala.
31. Great mountains of America. Volcano de Agua, Guatemala.
32. Great mountains of America. View of volcano Agua from the ruins of the old capital of Guatemala, destroyed by an earthquake September 8, 1541.
33. Country house, Guatemala.
34. Plantation in Guatemala.
35. City hall in Antigua, Guatemala.
36. Ruins of the old Palace of the Viceroys, Antigua, Guatemala.
37. Old capital and ruins of the Spanish Palace, Guatemala.
38. Government palace of Quesaltenango, Guatemala.
39. Guatemalan village.
40. Hacienda of Guatemala.
41. Country house in Guatemala.
42. Gathering coffee, Guatemala.
43. Indians of Guatemala.
44. Guatemalan mother and child.
45. Guatemalan plantation.

46. Peasants of Guatemala enjoying a holiday.
47. Group of Guatemalan peasants.
48. Native costume of Guatemala.
49. Indians of Guatemala.
50. The costume of peon woman, Guatemala.
51. Group of Guatemalan girls. Mme. Barrios in the center.
52. Ex-President Barrios, of Guatemala.
53. Portrait of Mme. Barrios, wife of the late President of Guatemala.
54. Mme. de Barrios, wife of the late President of Guatemala.
55. Dr. Ferdinand Cruz, ex-secretary of state, Guatemala.
56. Type of Guatemalan beauty; Señorita Lainfiesta.

The Republic of Honduras and the British colony of Honduras had 15 specimens, as follows:

1. Portrait of Luis Bogran, ex-President of Honduras.
2. Cuartel or barrack at Tegucigalpa, Honduras, after a revolution.
3. View of the suburbs of Comayagua, Honduras.
4. Bridge across the Choluteca River, Tegucigalpa, Honduras.
5. Rubber gathering in Central America.
6. Ancient rubber tree.
7. An ice-cream vender in Central America.
8. View of Belize, British Honduras, from the water.
9. Protestant Episcopal Church at Belize, British Honduras.
10. Governor-general's residence in Belize, British Honduras.
11. Court-house at Belize, British Honduras, and other buildings.
12. View of a street in Belize, capital of British Honduras.
13. A street scene in Belize, British Honduras.
14. Cavalry of Belize, British Honduras.
15. Model of a Honduras ranch.

The Republic of Salvador had 29 specimens, as follows:

1. Pier at Acajutla, Salvador.
2. View of Acajutla, Salvador, from the sea.
3. Landing at La Libertad, Salvador.
4. Ocean pier at La Libertad, Salvador.
5. Wharf at La Libertad, Salvador.
6. Theater, San Salvador.
7. Charcoal peddler in Salvador.
8. President's mansion, San Salvador.
9. Serving street dinners in Salvador.
10. On the outskirts of San Salvador.
11. South American laundress.
12. Volcano Ixalco from a distance, Salvador.
13. Great mountains of America. Volcano of Ixalco, Salvador.
14. Great mountains of America. Ilopango volcano, Salvador.
15. Chicken peddler in Salvador.
16. A rubber tree in Central America.
17. Central American plow and team.
18. San Salvador. (From description de l'Univers, 1633, Paris.)
19. Market place, Sonsonate, Salvador.
20. Group of natives, La Libertad, Salvador.
21. Cabildo, or prison, San Salvador.
22. National University, San Salvador.
23. New Cathedral at San Salvador.

24. Kiosk in the Central Park, San Salvador.
25. Ruins of National Palace at San Salvador. Destroyed by an earthquake.
26. Coffee estate near San Salvador.
27. View of La Libertad, Salvador, from the sea.
28. Landing place at La Union, Salvador.
29. Custom-house, Acajutla, Salvador.

The Republic of Nicaragua had 24 specimens, as follows:

1. Views of Nicaragua.
2. Ancient castle on Rio San Juan, Nicaragua. Photograph colored.
3. President's palace, Managua, Nicaragua.
4. Post-office and English church, Greytown, Nicaragua.
5. Nicaraguan fakir.
6. Hotel in Granada, Nicaragua.
7. Street scene, Nindiri, Nicaragua.
8. Village street in Nicaragua.
9. Typical native house in Nicaragua.
10. Street scene, Rivas, Nicaragua.
11. Giant of the forest, Nicaragua.
12. Residence, Rivas, Nicaragua.
13. Central American hammock.
14. Market woman of Nicaragua.
15. A hide-covered cart, Nicaragua.
16. Breadfruit tree, in Greytown, Nicaragua.
17. Hut of woodcutters in forest of Nicaragua.
18. Native women of Nicaragua.
19. Mombacho volcano, Nicaragua.
20. Nicaraguan farmhouse.
21. Country home in Nicaragua.
22. Nicaragua farmer.
23. Methods of building railroads in swamps of Central America.
24. Mosquito Indians. Banana planters.

The Republic of Costa Rica had 43 specimens, as follows:

1. Palace of the bishop, San Jose, Costa Rica.
2. Costa Rican woman making tort llas.
3. Interior of a house in Costa Rica.
4. Indian girl, Costa Rica.
5. Indian girl, Costa Rica.
6. Cemetery in San Jose, Costa Rica.
7. Pineapple plantation and palmetto palms.
8. A pineapple plantation.
9. Pineapple plant in bearing.
10. Central American woman carrying water.
11. Violin peddlers in Central America.
12. Cowhide bridge in Costa Rica.
13. Coffee tree in full bloom.
14. Coffee in the berry.
15. General view of a coffee plantation.
16. Picking the coffee berry.
17. Coffee culture. Stripping the trees of fruit.
18. Winnowing the coffee berry after it is crushed.
19. Drying the coffee berry.
20. Sluices used for washing the husk from the coffee berry.

21. The coffee berry on the drying ground.
22. Coffee culture. Carts ready for their loads.
23. Coffee culture. Packed and awaiting shipment to market.
24. Crushing the coffee berry by the Retrillo process.
25. Coffee culture. The workmen and their tools.
26. Coffee culture. On the road to the sorting house.
27. Vats in which the coffee berry is fermented.
28. Coffee culture. Loading for the sorting house.
29. Coffee in bloom.
30. Unloading the coffee berry at the drying ground.
31. Sorting the coffee.
32. Coffee culture. On the road to market.
33. Mountain house in Costa Rica.
34. The marimba. Costa Rica.
35. Cathedral at San Jose, Costa Rica.
36. Doña Pacifica Hernandez de Sota, wife of ex-President de Soto, of Costa Rica.
37. A lady of Costa Rica.
38. Costa Rican ladies.
39. Park opposite the cathedral of San Jose, Costa Rica.
40. A Costa Rican belle.
41. A ruined church in Costa Rica.
42. A young lady of Costa Rica.
43. Railway camp in Costa Rica.

The Republic of Colombia had 94 specimens, as follows:

1. Rafael Nunez, President of Colombia.
2. Doña Soledad, wife of President Nunez, of Colombia.
3. Bay of Colon.
4. Suburbs of Colon, Isthmus of Panama.
5. Aspinwall Monument and Protestant church at Colon, Isthmus of Panama.
6. Unloading ice at Colon.
7. Residence on the outskirts of Colon, Isthmus of Panama.
8. Panama Railway shops at Colon.
9. Town of Matuchin, on the Panama Railway.
10. Gateway of the old city of Panama.
11. Approach to Panama on the Panama Railway.
12. Pacific Mail steamship headquarters, Panama.
13. Bishop's palace at Panama.
14. South front of the city of Panama, showing the old sea wall.
15. Grand Central Hotel at Panama.
16. Ruins of the old Church of Santo Domingo, Panama.
17. General view of Panama, Colombia.
18. Entrance to the cemetery at Panama.
19. Cemetery at Panama.
20. Cemetery at Panama.
21. Ruins of old church of Santa Anna, Panama.
22. Interior of the old Convent of Santo Domingo, Panama.
23. Panama railroad shops.
24. Scene on the Panama Railway.
25. Site of the old city of Panama.
26. Wall of the old castle at Panama.
27. Panama laundry.
28. Pacific Mail Steamship Company's shops, Panama.
29. Puerta del Mar, or sea gate, Panama.

80. City of Panama from the beach.
81. North front of the harbor at Panama.
82. Old town of Chagres, on the Isthmus of Panama.
83. Tower of the old fortress at Panama.
84. Tropical home on the Isthmus of Panama.
85. Casements of the old fortress at Chagres, Isthmus of Panama.
86. View of Carthagena, Colombia.
87. Seat of the South American inquisition, now a tobacco factory, Carthagena, Colombia.
88. Early pictures of America from De Bry's voyages, 1595. Sir Francis Drake capturing Carthagena.
89. City of Carthagena, Colombia.
90. Street in Carthagena, Colombia.
91. Ruins of the old monastery, Carthagena, Colombia.
92. Scene on the Magdalena River, Colombia.
93. Steamboat on the Magdalena River, Colombia.
94. Navigation on the Magdalena River, Colombia.
95. Champan on the Magdalena River, Colombia.
96. View of Honda, head of navigation on Magdalena River, Colombia.
97. Champan, or freight boat, on the Magdalena River, Colombia.
98. Difficulties of transportation in Colombia. Machinery of mint on its way up the mountains to Bogota.
99. Over the mountains on a silla, Colombia.
100. The capitol at Bogota.
101. Plaza and cathedral at Bogota, Colombia.
102. The cathedral at Bogota, Colombia.
103. Church of San Diego, Bogota, Colombia.
104. Residence in Florian street, Bogota, Colombia.
105. House formerly occupied by General Bolivar, Bogota, Colombia.
106. Post-office in Florian street, Bogota, Colombia.
107. Bank of Colombia, Bogota, Colombia.
108. Monument to the martyrs of independence, Bogota, Colombia.
109. Corner Third and Florian streets, Bogota, Colombia.
110. Calle Florian, Bogota, Colombia.
111. Courtyard of Santo Domingo Convent at Bogota, Colombia.
112. Entrance to cemetery at Bogota, Colombia.
113. Farmhouse in Bogota, Colombia.
114. A country house near Bogota, Colombia.
115. Indian hut on the road to Bogota, Colombia.
116. Indians carrying bark to Bogota, Colombia.
117. Indians carrying wood on their way to Bogota, Colombia.
118. Trains of mules carrying cacao, resting under ceiba trees, Colombia.
119. Ox cart in Colombia.
120. House in Colombia.
121. Bird seller in Bogota, Colombia.
122. Indian women on the plains of Bogota, Colombia.
123. Flag of the Republic woven of native silk and beautifully embroidered by Señora de Canlos Ramirez, of Bogota.
124. Mules loaded with earthenware, Colombia.
125. Farmhouse in Colombia.
126. Species of pelican, Colombia.
127. Yoke of oxen hauling water, Colombia.
128. Native plow in Colombia.
129. Pack mules in Colombia.

80. Bird seller in Colombia.
81. Plantation overseer, Colombia.
82. Colombian peddler.
83. Masquerade party, Colombia.
84. Colombian peons on the way to market.
85. Tinaja (water jar) from Chiriqui, Isthmus of Panama.
86. Pieces of metal found in a tinaja at Chiriqui, Isthmus of Panama.
87. Petate, or mat, made of palm, Colombia.
88. Golden cross ornamented with a representation of the sun.
89. Poncho, or blanket, worn by the natives of Colombia.
90. Bark from the plains of Casahare, Colombia. Used by the Indians of the forest both for shelter and clothing.
91. Cup made from the horn of an ox by a cowboy on the Rio Negro, Colombia.
92. A Colombian peddler.
93. Native riding outfit, Colombia.
94. Mat weavers, Colombia.

The Republic of Venezuela had 76 specimens, as follows:

1. Simon Bolivar.
2. Portrait of Simon Bolivar.
3. Federal palace at Caracas, Venezuela.
4. View of Caracas, Venezuela.
5. View of the city of Caracas, Venezuela.
6. View of the city of Caracas, Venezuela.
7. Casa Amarilla—residence at Caracas of the President of Venezuela.
8. Interior of the Federal palace at Caracas, Venezuela.
9. Federal palace and legislative chambers, Caracas, Venezuela.
10. Patio, or interior courtyard, of the capitol at Caracas, Venezuela.
11. Statue of Simon Bolivar, Caracas, Venezuela.
12. Pantheon at Caracas, Venezuela, in which Bolivar is buried.
13. Dr. Rojas Paul, ex-President of Venezuela.
14. Gen. Guzman Blanco, ex-President and formerly Dictator of Venezuela, seated in his library.
15. Guzman Blanco, ex-President of Venezuela, wife and daughter, in patio of residence in Caracas.
16. Statue of Guzman Blanco, ex-President of Venezuela. Erected by himself. Pulled down by a mob in 1889.
17. Dr. Jesus Munoz Tebar, a prominent citizen of Venezuela.
18. Portrait of Gen. Guzman Blanco, formerly Dictator of Venezuela.
19. President Crespo, of Venezuela.
20. Pantheon at Caracas, where Bolivar is buried.
21. Public house at the entrance to the city of Caracas, Venezuela.
22. Interior of market house, Caracas, Venezuela.
23. Statue of Washington at Caracas, Venezuela.
24. Chapel at Caracas. Built by Madam Crespo, wife of the ex-President of Venezuela.
25. University of Venezuela at Caracas.
26. Railway station in Caracas, Venezuela.
27. Tomb of Bolivar, Caracas, Venezuela.
28. Street scene in Caracas, Venezuela.
29. Patio of a residence in Caracas, Venezuela.
30. Railway station in Caracas, Venezuela.
31. Bit of home life near Caracas, Venezuela.
32. Caracas Ganymede, Venezuela.

33. Laundry at Caracas, Venezuela.
34. Venezuelan laundry.
35. Group of Venezuelan señoritas.
36. View of the cemetery Paraiso in Caracas, Venezuela.
37. Cemetery Children of God, Caracas, Venezuela.
38. Venezuelan belles.
39. Theater at Caracas, Venezuela.
40. Residence street in Caracas, Venezuela.
41. Street in Caracas, Venezuela.
42. Picture of a miraculous virgin, Maracaibo, Venezuela.
43. Plaza and cathedral in Maracaibo, Venezuela.
44. Street in Maracaibo, Venezuela.
45. Street in Maracaibo, Venezuela.
46. On the beach at Macuto, a popular watering place.
47. View of the city of La Guaira, Venezuela.
48. View of the city of La Guaira, Venezuela.
49. Public bath house at Macuto, Venezuela.
50. Antimano, Venezuela.
51. Fruit peddler in Venezuela.
52. Making bread, Venezuela.
53. Family group in Venezuela.
54. Group of Venezuelan soldiers guarding the powder house.
55. Caravan on the old Spanish road between La Guaira and Caracas, Venezuela.
56. Group of ox carts on the Spanish road between La Guaira and Caracas.
57. Load of merchandise en route to Caracas, Venezuela.
58. Old veteran, Venezuela.
59. Coffee grove near Caracas, Venezuela.
60. Old fortification above La Guaira, Venezuela.
61. Drying coffee in patio of an hacienda, Caracas, Venezuela.
62. Valley of Caracas, Venezuela, showing sugar plantations.
63. Corral of a Venezuelan ranch.
64. River Guire flowing through a coffee plantation, Venezuela.
65. Coffee drying in the sun, Caracas, Venezuela.
66. Sugar plantation near Antimano, Venezuela.
67. Coffee and sugar plantation, Venezuela.
68. Venezuelan street car.
69. Scene on a coffee plantation, Venezuela.
70. Avenue of poplars, coffee hacienda, Venezuela.
71. Coffee plantation in Venezuela.
72. Home of a peasant, Venezuela.
73. Roadside dwellings in Venezuela.
74. Scene on railway near Caracas, Venezuela.
75. Country house in Venezuela.
76. Railway viaduct on the road between La Guaira and Caracas.

The Republic of Ecuador had 49 specimens, as follows:

1. Señor Don Antonio Flores, ex-President of Ecuador.
2. Don Antonio Flores, recently President of Ecuador, and his children.
3. Plaza and cathedral at Quito, Ecuador.
4. Views of Quito, Ecuador.
5. Cathedral and plaza at Quito, Ecuador.
6. Calle de la Compania, Quito, Ecuador.
7. Fiesta in the Plaza, Quito, Ecuador.
8. Lady of Quito, Ecuador.

9. Indian stoneworkers of Quito, Ecuador.
10. Views of Guayaquil, Ecuador.
11. Chimbo railway station, Guayaquil, Ecuador.
12. Calle del Comercio, Guayaquil, Ecuador.
13. Plaza de Bolivar, Guayaquil, Ecuador.
14. Prominent street corner in Guayaquil, Ecuador.
15. Country house in Guayaquil. Ecuador.
16. Church in Guayaquil, Ecuador.
17. Country house in Ecuador.
18. The country house in Ecuador.
19. A country house in Ecuador.
20. Country house in the lowlands of Ecuador.
21. Ranch houses in the swamp lands of Ecuador.
22. Babahoya, on the Guayas River, Ecuador.
23. Chimborazo, from the slopes above Guarandak, 21,615 feet high.
24. Chimborazo, Ecuador.
25. Chimborazo, Ecuador (volcano).
26. Antisana, Ecuador, 19,158 feet high.
27. Volcano Chimborazo, Ecuador, 21,420 feet above the sea.
28. Great mountains of America. Volcano Cotopaxi, 19,638 feet high.
29. Peak of Sincholagua, Ecuador, 16,365 feet high.
30. Cotocachi, Ecuador, 16,301 feet high.
31. Cayambe, Ecuador, 19,186 feet high.
32. Tropical beauty.
33. A South American harpist.
34. Ranch in the Tropics.
35. Common carrier, Ecuador.
36. Indians of oriental Ecuador.
37. Indian reed pipes, Ecuador.
38. Scene on the Guayas River, Ecuador.
39. Tambos, or resting place, on the slopes of Chimborazo. Ecuador.
40. Ecuador girl in native costume.
41. Musicians in Ecuador.
42. Arriero, or mule driver, Ecuador.
43. A South American bread peddler.
44. A study of tropical vegetation.
45. Indian home in the Tropics.
46. Chaquis, Ecuador.
47. Native customs and costumes of Ecuador.
48. Native customs and costumes of Ecuador.
49. A street in Guayaquil, Ecuador.

The Republic of Peru had 103 specimens, as follows:

1. Facsimile of the Declaration of Independence of Peru.
2. Prehistoric masonry near Cuzco.
3. Prehistoric wall near Cuzco, Peru.
4. Ex-President Iglesias of Peru.
5. General Andres Avelino Caceres, ex-President of Peru.
7. Manuel Pardo, ex-President of Peru.
8. Admiral Don Miguel Grau, hero of the war between Chile and Peru.
9. Bird's-eye view of Lima, Peru.
10. View of the city of Lima, Peru, in 1800.
11. General view of Lima, Peru.
12. View of Lima, Peru.

13. Old Government palace at Lima, Peru, erected by Francisco Pizarro.
14. Residence of the Torre-Taglia family, Lima. Peru.
15. Street scene in Lima, Peru.
16. Cathedral of Lima, Peru.
17. Pavilion on exposition grounds, Lima, Peru.
18. Cloisters of the Monastery of San Agustin, at Lima, Peru.
19. Copacabana, the seat of the Incas of Peru.
20. Statue of Simon Bolivar, Plaza Bolivar, Lima, Peru.
21. River Rimac, Lima, Peru.
22. Cemetery in Lima, Peru.
23. Garden of Eden of the Incas, Peru.
24. Inca of to-day.
25. A daughter of the Incas.
26. Terraced gardens of the Incas in the Andes. Peru.
27. Inca queen and princess from a village in the Andes of Peru.
28. Approach to Lake Titicaca, Peru.
29. Steamboat landing of Lake Titicaca, Peru.
30. Balsas on Lake Titicaca, Peru.
31. Steamer *Yavari* on Lake Titicaca, Peru.
32. Steamer *Yapuda* on Lake Titicaca, Peru.
33. Railway station at Lake Titicaca, Peru.
34. Town of San Juan on the Oroya Railroad, Peru.
35. Scene on the Oroya Railroad, Peru.
36. Village of Chiclay, Oroya Railroad, Peru: 12,200 feet above the sea.
37. View on the Oroya Railroad, Peru.
38. A canyon in the Andes on the Oroya Railroad, Peru.
39. Valley in the Andes on the Oroya Railroad, Peru.
40. View of the Oroya Railway, showing terraces of ancient Peruvians.
41. The tunnels of Parac on the Oroya Railroad.
42. Oroya Railroad, Peru; handcar descending.
43. Bridge on the Oroya Railroad, Peru.
44. Oroya Railway, Peru. Method of crossing the famous Verrugas bridge after it was partially destroyed.
45. Village of Chiclayo, terminus of the Oroya Railroad.
46. Bridge on Oroya Railroad, Peru.
47. Old Verrugas bridge, Oroya Railroad. Peru.
48. General view of Mollendo from the sea, Peru.
49. Calle del Comercio, Mollendo, Peru.
50. Fourth of July Hotel at Mollendo, Peru.
51. United States consulate, Mollendo, Peru.
52. Group of children at Mollendo, Peru.
53. Types of Peruvian beauty.
54. Type of Peruvian beauty.
55. Peruvian belle.
56. Belle of Lima, Peru.
57. Peruvian beauty.
58. Milk woman, Lima, Peru.
59. Peruvian lady.
60. Portrait of a young girl of Lima, Peru.
61. Portrait of a group of the belles of Peru.
62. Portrait of a lady of Lima, Peru.
63. Young lady of Peru.
64. Beach at Ancon, Peru.
65. City of Puno, Peru.

66. Post-office at Pacasmayo, Peru.
67. Car moved by sail on the pier at Pacasmayo, Peru.
68. Private residence at Miraflores, Peru.
69. Cowhide bridge over the Rimac, Peru.
70. Fishing canoes on the beach at Pacasmayo, Peru.
71. Private residences at Miraflores, Peru.
72. Bridge across the Rimac, Lima, Peru.
73. Soldiers and their women at the barracks, Peru.
74. Street in Paita, Peru.
75. Water donkeys at Paita, Peru.
76. Plaza at Paita, Peru.
77. Llama and attendant, Peru.
78. Street in Peru, showing a drove of loaded llamas.
79. Water colors (23), painted by an Aymara Indian of Peru.
80. Picture of a balsa, a boat used by the natives of Peru at the time of conquest.
81. Llamas on a plantation, Peru.
82. Fairlie's double end engine.
83. Caballitos of straw used by Peruvian fishermen.
84. Hoisting cattle on board steamer at Pacasmayo, Peru.
85. Cloisters of the Convent of San Francisco, Lima, Peru.
86. Church of San Agustin, Lima, Peru.
87. Church of San Francisco, Lima, Peru.
88. Cloisters of Santo Domingo, Lima, Peru.
89. Cloisters of the Church of San Francisco, Lima, Peru.
90. Canonization of Santa Rosa de Lima.
91. Market place, Arequipa, Peru.
92. View of the city of Arequipa, Peru, and volcano Misti.
93. Residence of the railway superintendent, Arequipa, Peru.
94. View of Arequipa, Peru, and the volcano Misti.
95. The plaza at Arequipa, Peru.
96. Observatory of Harvard University, near Arequipa, Peru.
97. Street of Santo Domingo, in Arequipa, Peru.
98. Street of the Bridges, Arequipa, Peru.
99. Portico of military barracks, Arequipa, Peru.
100. Plaza de Armas, Arequipa, Peru.
101. Railway station at Arequipa, Peru.
102. Street of the Bridges, Arequipa, Peru.
103. Cemetery at Arequipa, Peru.

The Republic of Bolivia had 76 specimens, as follows:

1. Facsimile of the Declaration of Independence of Bolivia.
2. Gen. Antonio Jose de Sucre, associate of Bolivar in the war for independence.
3. Mountain of Potosi, Bolivia, in 1600.
4. Señor Don Aniceto Arce, ex-President of Bolivia.
5. Plaza and Federal palace, La Paz, Bolivia.
6. Medals issued by the city of Potosi, Bolivia, in 1825, in honor of Simon Bolivar.
7. Philharmonic Society, La Paz, Bolivia.
8. Views of the city of La Paz, Bolivia.
9. View of the city of La Paz, Bolivia.
10. View of the city of La Paz, capital of Bolivia.
11. Residence of the President at La Paz, Bolivia.
12. Celebration of Independence Day. La Paz, Bolivia.
13. Addressing "Our Lady of La Paz." Religious procession, Bolivia.
14. Native of La Paz, Bolivia.

15. On the stage road from Chillalaya to La Paz, Bolivia.
16. Oconisto, last change on road from Chillalaya to La Paz, Bolivia.
17. Religious procession in the plaza at La Paz, Bolivia.
18. Cemetery at La Paz, Bolivia.
19. Cemetery at La Paz, Bolivia.
20. Ox cart at Challapampa, La Paz, Bolivia.
21. Diligence from Chillalaya to La Paz, Bolivia.
22. The city of Potosi, Bolivia, and environs.
23. Liberty statue in Pichincha, Potosi, Bolivia.
24. The municipal building and prefecture at Potosi, Bolivia.
25. Bolivian girl.
26. Bolivian girl.
27. Bolivian girl.
28. Common carriers of Bolivia.
29. Types of natives of Bolivia.
30. Bolivian peon.
31. Indian car porters, Chillalaya, Bolivia.
32. Bolivian laundress.
33. Bolivian Indian in masquerade dress.
34. Breaking silver ore, Bolivia.
35. Loaded donkey in Bolivia.
36. Villa of Ginebra, Yungas, Bolivia.
37. Public square of Chuhumani, Yungas, Bolivia.
38. Street and view on Chuhumani, Yungas, Bolivia.
39. Kitchen in Yungas, Bolivia.
40. Plaza of Chupa, Yungas, Bolivia.
41. Indian cocoa gatherers, Yungas, Bolivia.
42. Church of Chupa, Yungas, Bolivia.
43. Native house at Mapiri, Bolivia.
44. Hotel at Copacabama, Bolivia.
45. Near view of the city of Sucre, Bol via.
46. Procession of the Cross, Sucre, Bolivia.
47. Blessing the corners of the plaza, religious procession, Sucre, Bolivia.
48. Street corner in Bolivia.
49. Reduction works of the Huachaco mine, Bolivia.
50. View of Colquechaca from San Miguel, Bolivian silver mines.
51. Lake Titicaca, Bolivian shore.
52. Miraculous shrine of Copacabana, Bolivian shore of Lake Titicaca.
53. Aullagas village, near Colquechaca, Bolivia, 18,000 feet above the sea.
54. Cabin in the mountains.
55. View of Lake Titicaca, Bolivia, showing balsas.
56. Copper mines at Corocoro, Bolivia.
57. Copper mines of Corocoro, Bolivia.
58. Hill of Corocoro. Copper mines of Bolivia.
59. View of the valley, Corocoro, Bolivia.
60. Panorama of Corocoro, Bolivia.
61. Driers of copper ore, mines of Corocoro, Bolivia.
62. Breakers of copper ore, mines of Corocoro, Bolivia.
63. Washing copper ore, mines of Corocoro, Bolivia.
64. Temple at Copacabana, Bolivia.
65. The Uyuni Hotel, Bolivia.
66. San Pedro bridge on Antofagasta and Huanchaca Railroad, Bolivia.
67. Boat on the Mapiri River, Bolivia.
68. View of the town of Chillalaya, Bolivia.

69. Group of houses in Chirca. Yungas, Bolivia.
70. The town of Colquechaca, Bolivia, from Amigos mines.
71. En route to Ayoma, Bolivia.
72. Panorama of Oruro, Bolivia.
73. Raft of balsa on the Mapiri River. Bolivia.
74. At the summit of Livichuco, Bolivia.
75. Bridge constructed of osiers, Bolivia.
76. Railway station in Bolivia.

The Republic of Chile had 82 specimens, as follows:

1. View of the Andes in Santiago, Chile.
2. View of the city of Santiago, Chile, in 1600.
3. Chamber of Deputies, Santiago, Chile.
4. Interior of the Chamber of Deputies, Santiago, Chile.
5. Residence of Señora Cousino, Santiago, Chile.
6. Trading booths in the Alameda, Santiago, Chile.
7. A residence in Santiago, Chile.
8. Calle del Huerfano, Santiago, Chile.
9. Public festing in the Alameda, Santiago, Chile.
10. Monument erected in Santiago, Chile, on the spot where more than 1,000 young girls were burned to death.
11. Exposition building at Santiago, Chile.
12. Exposition building at Santiago, Chile.
13. Don Jorge Montt, President of Chile.
14. Don Jose M. Balmaceda, late President of Chile, and his cabinet.
15. Don Jose Manuel Balmaceda, late President of Chile.
16. Ex-President Santa Maria, of Chile.
17. General view of Valparaiso, Chile.
18. Victoria street, Valparaiso, Chile.
19. A street scene in Valparaiso, Chile.
20. Dairy lunch stand in streets of Valparaiso.
21. Belle of Chile.
22. Young lady of Chile.
23. Belle of Chile dressed for morning mass.
24. Belle of Chile dressed for mass.
25. Belle of Santiago, Chile.
26. Chilean lady in visiting dress.
27. Lady of Santiago, Chile.
28. Portrait of a Chilean beauty, Santiago, Chile.
29. Portrait of a young Chilean lady.
30. A young lady of Santiago, Chile.
31. Peasant woman in Chile.
32. Type of Chilean "roto" (peasant).
33. Type of Chilean peon.
34. A Chilean country house.
35. Country building in Chile.
36. A Chilean cowherd and his equipment.
37. Cowherd and his home, Chile.
38. Country village in Chile.
39. Country huts, Chile.
40. Country carts with produce in market place, Chile.
41. Water peddler, Los Andes, Chile.
42. Chilean dray and attendant.
43. Indians of the frontier, Chile.

44. Street merchant, Chile.
45. Chilean washerwoman.
46. Bullock cart on its way to market, Chile.
47. Trail across the Andes from Chile to the Argentine Republic.
48. Wood sellers, Chile.
49. View of railway between Santiago and Valparaiso, Chile.
50. Woman street-car conductor, Santiago, Chile.
51. The Plaza Arturo, Iquique, Chile.
52. Nitrate bed, Iquique, Chile.
53. Railway station in Chile.
54. Araucanian mother and child, Chile.
55. Araucanian mother and child, Chile.
56. Araucanian women and children, Chile.
57. Araucanian family, Chile.
58. Araucanian boy, native of Chile.
59. Wife of an Araucanian chief.
60. Wife of an Araucanian chief, Chile.
61. Araucanian Indian woman, Chile.
62. Araucanian girl, native of Chile.
63. Araucanian Indian hut, Chile.
64. Island of Juan Fernandez, the home of Robinson Crusoe.
65. Scene on the island of Juan Fernandez. Home of Robinson Crusoe.
66. Robinson Cruso's "Lookout," Juan Fernandez Island, as it appears at present.
67. Bay and anchorage at Juan Fernandez Island.
68. Ranch house at Juan Fernandez Island.
69. Zamacueca, or national dance, Chile.
70. Zamacueca, or national dance, Chile.
71. Dancing the zamacueca, Chile.
72. Mount Aconcagua, Chile.
73. Great mountains of America. Summit of Aconcagua, Chile, 22,418 feet high.
74. House in the country, Chile.
75. Festivities during the harvest, Chile.
76. Grape train in a vineyard, Chile.
77. Street scene in the village of Limache, Chile.
78. Mount Santa Lucia-Santiago, Chile, Andes in the distance.
79. Grape train in the vineyard, Chile.
80. Chilean ironclad *Almirante Cochrane.*
81. *Esmerelda,* Chilean man-of-war.
82. Hieroglyphic stone near Canquenes, Chile.

The Argentine Republic had 41 specimens, as follows:

1. Facsimile of the Declaration of Independence of the Argentine Republic.
2. Dr. Don Luis Saenz Pena, President of the Argentine Republic.
3. Señor Juarez Celman, ex-President of the Argentine Republic.
4. Gen. Julio A. Roca, ex-President of the Argentine Republic.
5. Gen. Rosas, formerly Dictator of the Argentine Republic.
6. Custom-house, Buenos Ayres, Argentine Republic.
7. Bank at Buenos Ayres, Argentine Republic.
8. Federal palace at Buenos Ayres, Argentine Republic.
9. Government buildings at Buenos Ayres, Argentine Republic.
10. Post-office at Buenos Ayres, Argentine Republic.
11. Stock exchange, Buenos Ayres, Argentine Republic.
12. Interior of the penitentiary at Buenos Ayres.
13. Bullock train in the market place of Buenos Ayres, Argentine Republic.

14. View of the city of Buenos Ayres in the seventeenth century.
15. View of the city of Buenos Ayres, 1807.
16. Country scene in the Argentine Republic.
17. Branding cattle at Punta Negra, Argentine Republic.
18. Scene on the highway over the Andes between the Argentine Republic and Chile.
19. El Puente del Inca.
20. Work on the trans-Andean railway between Argentine Republic and Chile.
21. View of the rocking stone of Taudil.
22. Patagonian Indians.
23. A toldo or tent of the Patagonian Indians.
24. Toldo or tent of the Fuegian Indians.
25. Patagonian women clad in their ostrich robes.
26. A Patagonian belle.
27. Straits of Magellan.
28. Scene in the Straits of Magellan.
29. Glacier in the Straits of Magellan.
30. Glaciers in the Straits of Magellan.
31. Desolation Island, Straits of Magellan.
32. Desolation Island, Straits of Magellan.
33. Desolation Island, Straits of Magellan.
34. Desolation Island, Straits of Magellan.
35. Punta Arenas, Straits of Magellan.
36. King Williams Land, Straits of Magellan.
37. Darwins Inlet, Straits of Magellan.
38. Cape Pillar, entrance to Straits of Magellan.
39. View of Cape Pillar, Straits of Magellan.
40. Long Reach, Straits of Magellan.
41. Tierra del Fuego, above Long Reach, Straits of Magellan.

The Republic of Uruguay had 45 specimens, as follows:

1. Facsimile of the Declaration of Independence of the Republic of Uruguay.
2. Bird's-eye view of Montevideo.
3. General view of Montevideo, Uruguay.
4. Government Palace at Montevideo, Uruguay.
5. Cathedral at Montevideo, Uruguay.
6. Custom-house, Montevideo, Uruguay.
7. City hall, Montevideo, Uruguay.
8. Independence Square, Montevideo, Uruguay.
9. Plaza Independencia, Montevideo, Uruguay.
10. Theater of the Sun, at Montevideo, Uruguay.
11. Post-office, Montevideo, Uruguay.
12. School of Arts and Sciences, Montevideo, Uruguay.
13. Oriental Hotel, in Montevideo, Uruguay.
14. Principal railway station, Montevideo, Uruguay.
15. British Bank of South America, Montevideo, Uruguay.
16. Club of Uruguayo, Montevideo, Uruguay.
17. Bank of Rio de la Plata, Montevideo, Uruguay.
18. National penitentiary, Montevideo, Uruguay.
19. National prison, Montevideo, Uruguay.
20. Charity hospital at Montevideo, Uruguay.
21. National Insane Asylum, Montevideo, Uruguay.
22. Italian hospital, Montevideo, Uruguay.
23. Headquarters of the national lottery, Montevideo, Uruguay.

24. Methodist church at Montevideo, Uruguay.
25. Produce trains in the Market Square of Montevideo.
26. Park of Montevideo, Uruguay.
27. A country house in Montevideo, Uruguay.
28. Dr. Don Julio Herrera y Obes, President of Uruguay.
29. Don Maximo Santos, ex-President of Uruguay.
30. Young lady of Montevideo, Uruguay.
31. Lady of Montevideo, Uruguay.
32. Montevidean brunette.
33. Montevidean blonde.
34. Wife of Uruguayan statesman.
35. Type of Uruguayan beauty.
36. Belle of Montevideo, Uruguay.
37. Old mills in Uruguay.
38. Old mill in Uruguay.
39. A country road in Uruguay.
40. Farmer's cart in Uruguay.
41. Country house, Montevideo, Uruguay.
42. Suburban villa in Uruguay.
43. Country residence near Montevideo, Uruguay.
44. Method of slaughtering cattle in Uruguay.
45. Country residence in Uruguay.

The Republic of Paraguay had 13 specimens, as follows:

1. Don Gaspar Francia, first President of Paraguay.
2. Lopez II, formerly Dictator of Paraguay.
3. View of the unfinished palace of Dictator Lopez.
4. Market place in Asuncion, Paraguay.
5. South American peddler.
6. A tropical beauty.
7. Water carrier in Paraguay.
8. Transportation facilities in Asuncion, Paraguay.
9. South American bird peddler.
10. Cocoa palm; study of fruitage.
11. Group of American peons.
12. A peon cabin, South America.
13. Funeral of an angelito (angel-child), a common sight in Paraguay.

The United States of Brazil had 93 specimens, as follows:

1. Manuel Deodoro da Fonseca, late President of the United States of Brazil.
2. Dom Pedro II, late Emperor of Brazil.
3. Dom Pedro, late Emperor of Brazil.
4. The late Empress of Brazil.
5. Princess Isabela of Brazil.
6. Count d'Eu, husband of Princess Isabela of Brazil.
7. Harbor of Rio de Janeiro, Brazil.
8. Shipping in the Bay of Rio de Janeiro, Brazil.
9. Docks and arsenal at Rio de Janeiro, Brazil.
10. Avenue of Palms, Botanical Garden, Rio de Janeiro, Brazil.
11. Avenue of Palms, Brazil.
12. Palm avenue in Botanical Garden, Rio de Janeiro, Brazil.
13. Avenue of Palms, Botanical Garden, Rio de Janeiro, Brazil.
14. Avenue of Palms, Botanical Gardens, Rio de Janeiro, Brazil.
15. Fan palms, Botanical Garden, Rio de Janeiro, Brazil.

16. Glimpse of a tropical forest.
17. Types of tropical scenery.
18. Government hospital at Rio de Janeiro, Brazil.
19. Cathedral and ancient palaces in Rio de Janeiro, Brazil.
20. Palace of the minister of agriculture at Rio de Janeiro, Brazil.
21. Post-office at Rio de Janeiro, Brazil.
22. Post-office at Rio de Janeiro, Brazil.
23. Government printing office at Rio de Janeiro, Brazil.
24. Government mint at Rio de Janeiro, Brazil.
25. Palace of the late Emperor at San Christovao, Brazil.
26. Governors Island, from Arsenal Point, Rio de Janeiro, Brazil.
27. In the market place, Rio de Janeiro, Brazil.
28. A market place in South America.
29. A market place in South America.
30. Traveling dairy in Rio de Janeiro, Brazil.
31. Great mountains of America. Mount Corcovado, near Rio de Janeiro, Brazil.
32. Petropolis, Brazil.
33. General view of Bahia, Brazil.
34. Bahia, Brazil.
35. City of Salvador (Bahia), Brazil.
36. Streets in Bahia, Brazil.
37. Bahian servant, Brazil.
38. Banana seller at Bahia, Brazil.
39. Light-house at entrance to port of Bahia, Brazil.
40. Two boys of Bahia, Brazil.
41. Brazilian negress and child
42. Brazilian negress.
43. Negro group in Brazil.
44. Negro woman of Bahia.
45. Negress of Bahia.
46. Street scene, carts, and tramway, Bahia, Brazil.
47. View of the Bay of Bahia, Brazil.
48. Negress of Bahia, Brazil.
49. Framework showing construction of a native house, Bahia, Brazil.
50. Grove of cocoanut palms, Bahia, Brazil.
51. A South American policeman.
52. Group of South American peons.
53. Glimpse of Pernambuco, Brazil.
54. Residence at Caxanga, Pernambuco, Brazil.
55. Reef and harbor, Pernambuco, Brazil.
56. View of the harbor, Pernambuco, Brazil.
57. Opera house at Pernambuco, Brazil.
58. Harbor at Pernambuco, Brazil.
59. President's palace, Pernambuco, Brazil.
60. Carrying sugar cane to mill, Pernambuco, Brazil.
61. Cadets of a manual training school, Para, Brazil.
62. Interior of manual training school, Para, Brazil.
63. Interior of farmhouse in South America.
64. Group of school children and schoolhouse, Ilha Grande, Brazil.
65. Native canoe and boatmen, Ilha Grande, Brazil.
66. Works of Arroyo dos Ratos Coal Company.
67. Shaft of a coal mine, Arroyo dos Ratos, Brazil.
68. Water front, Rio Grande, Brazil.
69. Wagons and teams, Curityba, Brazil.

70. Town of Angra dos Reis, Brazil.
71. A milkman, Porto Alegre, Brazil.
72. Brazilian laundry, Porto Alegre, Brazil.
73. Washerwoman at a fountain in Brazil.
74. Brazilian washerwoman, Porto Alegre, Brazil.
75. Scene on the Amazon.
76. Cayapo Indian chief in costume, Brazil.
77. Appicaz Indian chief in costume, Province of Amazonas, Brazil.
78. Indian chief from the upper part of the Amazon
79. Steamboat on Jacuhy River, Brazil.
80. Garitea on Madeira River, Brazil.
81. Post and village of Tabatinga, on the Amazon, Brazil.
82. Front view of a native thatched hut, Parahyba.
83. Baker's wagon, Parahyba, Brazil.
84. Native house in Parahyba, Brazil.
85. Fruit seller in Brazil.
86. Bit of virgin forest, Brazil.
87. Brazilian ox cart or farm wagon.
88. Water carrier in Brazil.
89. Native of Paranagua, Brazil.
90. Types of Brazilian plantation hands.
91. Familiar street scene in Brazil.
92. View of a pineapple plantation.
93. A rubber tree.

The West Indies had 86 specimens, as follows:

1. Family of Hindoo coolies, British Guiana.
2. Group of Hindoo coolies, British Guiana.
3. Group of Hindoo coolies, British Guiana.
4. Hindoo coolie, British Guiana.
5. Coolie woman, British Guiana.
6. Coolie belle, British Guiana.
7. Coolie mother and child, British Guiana.
8. Coolie belle, British Guiana.
9. Coolie magician, British Guiana.
10. Coolie musicians, British Guiana.
11. Group of coolies in Trinidad.
12. Coaling station at Kingston, Jamaica,
13. Coffee tree in Blue Mountains, Jamaica.
14. Ceiba, or silk cotton trees, Jamaica.
15. Avenue of cocoa palms, Nassau, Bahama Islands.
16. Cocoa palm at Nassau, Bahama Islands.
17. Banyan tree at Nassau, Bahama Islands.
18. Silk cotton tree in Nassau, Bahama Islands.
19. Habana, Cuba, in 1600.
20. Habana in 1633.
21. Ancient tower at Habana.
22. Santiago, Cuba. Islands near the entrance, with summer villa.
23. Moro Castle, Santiago, Cuba.
24. Cuban coast near Santiago and the mountain Gran Piedra.
25. General view of Santiago, Cuba.
26. Cuban plowman.
27. "El Templete," a chapel erected upon the spot where the first mass was celebrated in Cuba.

28. Statue of "La India," on the Prado, Habana, Cuba.
29. An omnibus on the Prado, Habana.
30. Moro Castle, Habana.
31. Sugar cane, pineapples, and bananas, Cuba.
32. A group of royal palms near Habana.
33. Cuban huts.
34. Farmhouse in Cuba.
35. Cuban peon and child.
36. Cuban negroes dancing on Christmas Day.
37. Negro quarters in Cuba.
38. A sugar plantation in Cuba.
39. Sugar cane in Cuba.
40. Sugar estate in Cuba.
41. A Cuban plantation.
42. Sugar plantation, Cuba.
43. Sugar plantation, Cuba.
44. Sugar plantation, Cuba.
45. Sugar plantation, Cuba.
46. Sugar plantation, Cuba.
47. Sugar plantation, Cuba.
48. Load of sugar cane, Cuba.
49. Sugar mill in Cuba.
50. A Cuban sugar mill.
51. A sugar mill in Cuba.
52. A sugar mill in Cuba.
53. Sugar plantation in Cuba.
54. A sugar plantation in Cuba.
55. Vacuum pans of a sugar mill in Cuba.
56. Sugar plantation, Cuba.
57. A sugar plantation, Cuba.
58. Tobacco plant in Cuba.
59. St. Thomas, from the bay, West Indies.
60. Spanish water monkeys, modern.
61. Creole woman in Martinique.
62. Loading oranges at Martinique, West Indies.
63. Entrance to the harbor of Curaçao, Dutch West Indies.
64. Governor's palace at Curaçao, Dutch West Indies.
65. Convent of Curaçao, Dutch West Indies.
66. Government house, Jewish synagogue, and Masonic lodge, Curaçao, Dutch West Indies.
67. Club house and main street, Curaçao, Dutch West Indies.
68. Some ancient mansions, Curaçao, Dutch West Indies.
69. Bridge across the lagoon, Curaçao, Dutch West Indies.
70. Tropical country house, Curaçao, Dutch West Indies.
71. A Carib girl, West Indies.
72. A street in Curaçao, Dutch West Indies.
73. Residence street in Curaçao, Dutch West Indies.
74. Street in Curàçao, Dutch West Indies.
75. Street in Curaçao, Dutch West Indies.
76. Pontoon bridge across the lagoon, Curaçao, Dutch West Indies.
77. Peddling dulces in the West Indies.
78. View of Basse Terre, Guadeloupe.
79. Crapauds, or native frogs, island of Dominica.
80. Hercules beetles, island of Dominica.

81. Fragrant grass roots, Guadeloupe.
82. Jumbie beans and Job's tears, from St. Vincent, West Indies.
83. Petrification from Antigua, West Indies, including petrified coral and cocoa palm.
84. "Cut coins" from Tortola, West Indies.
85. Epaulet worn at Waterloo.
86. "Swizzle sticks" from Guadeloupe.

The Republic of Santo Domingo had 29 specimens, as follows:

1. First map of Santo Domingo.
2. First map of Santo Domingo. Made by Fernando Columbus.
3. Native hut thatched with palm, Santo Domingo.
4. Entrance to the harbor of Santo Domingo.
5. View of Santo Domingo from the bay.
6. Gateway in the wall and sentry boxes of the old city of Santo Domingo.
7. View of the citadel of Santo Domingo from the sea.
8. Gates of the city of Santo Domingo.
9. Glimpse of Santo Domingo.
10. View of Santo Domingo city.
11. Old church at Santo Domingo.
12. Typical scene in Santo Domingo city. Casa de Colon.
13. Cloister of the convent of San Francisco, Santo Domingo.
14. Cloister of cathedral at Santo Domingo.
15. Ruins of the old convent of San Francisco, at Santo Domingo.
16. Ruins of the old convent of San Francisco.
17. Ruins of an old church in Santo Domingo.
18. Petrifaction from Santo Domingo.
19. Roll of native tobacco, Santo Domingo.
20. Native saddle and saddlebags, Santo Domingo.
21. Coins of Santo Domingo.
22. Old coins found in ruined city.
23. Some Mexican coins of the time of Cortez.
24. Sabers from Santo Domingo.
25. Old machete, or Dominican cutlass, used in several revolutions by a brave soldier.
26. City of Puerto Plata.
27. Common way of landing luggage from the steamers, Puerto Plata.
28. Bullock with girl on its back, Puerto Plata, Santo Domingo.
29. Crosses erected near La Vega, Santo Domingo.

IMPORTANCE AND FEASIBILITY OF UNITED STATES COMMERCE WITH THE LATIN-AMERICAN COUNTRIES.

The people of Mexico and Central and South America are almost wholly occupied with agricultural and mineral industries. Cattle and sheep are raised in all the subtropical and temperate countries, and sugar and coffee flourish in all of them as far south as Chile and Argentina. The natural products of the soil, such as india rubber, gutta-percha, cocoa, timber, dyewoods, cinchona bark, etc., are important items of commerce, and considerable crops of grain are harvested annually in Argentina, Chile, and Uruguay, and the rapid progress of the cereal products of the former country threatens serious competition for the United States. In all of the countries mining constitutes an

important and growing industry, especially in Mexico, Honduras, Peru, Bolivia, and Chile. There are very few mechanical industries, and those which exist are of the rudest sort, except in Mexico and Argentina, where some modern machinery has been introduced.

The population of Mexico and Central and South America is almost wholly agricultural. Cattle and sheep are raised in all the countries. The coffee plant and sugar cane flourish in all the countries south of the United States as far as Chile and Argentina. The natural products of the soil, such as gutta-percha, india rubber, cocoa, woods, etc., are important items of commerce. Considerable crops of grain are harvested in Argentina, Chile, and Uruguay. The trade in tropical fruit is large, especially in the Central American States and West Indies. Mining constitutes an important and growing industry, especially in Chile, Ecuador, Colombia, Peru, Honduras, Bolivia, Venezuela, and Mexico, and employs a large proportion of the population. The manufacturing population is inconsiderable.

The annual value of the merchandise imported by the countries south of the Gulf of Mexico and the Rio Grande reaches above $600,000,000. This comprises prepared food products of the temperate zone, materials for clothing, and manufactured articles of every description.

Of the aggregate imports, the United States, until recently, furnished only about 10 per cent, or $60,000,000, but the amount has been increased since the movement to expand our trade in that direction to about $120,000,000.

Breadstuffs and provisions, agricultural implements, machinery, railway supplies, lumber, refined petroleum, and a few other articles in which we excel, have constituted our exports to Latin America. All other merchandise has been purchased in Europe, and the manufacturers of that continent have given the peculiarities of the market careful study in order to supply what is wanted, prepared to suit the requirements of the people. They make a class of goods for the South American trade, especially adapted to the climate, the conditions, the tastes, and the wants of the consumers, which in different countries are so essentially different that the merchandise intended for one market is not salable in the others. And the difference in the conditions that govern the domestic trade in the United States is even greater.

It is conceded that the ability and the ingenuity of the American manufacturers are equal to any of their rivals and superior to most of them. Recognition of the superiority of American merchandise is found in the frequent forgery of our trade-marks and the imitation of our wares in the goods manufactured in Europe for those markets. The consumer in South America knows that the cotton fabrics woven in this country are usually better than those woven in Europe. Hence the European manufacturer sometimes so labels his goods as that they appear to have been made in the United States.

OBSTACLES TO THE EXTENSION OF UNITED STATES COMMERCE IN LATIN-AMERICAN COUNTRIES.

1. Neglect or refusal to make the required style of goods.

It is conceded by all who have actually engaged or had experience in this trade that one of the greatest obstacles to the export trade of the United States is the unwillingness or inability of our merchants and manufacturers to produce or provide the classes of goods required for the market of those countries. The manufacturers of this country have, until recently, been absorbed in the production of articles required for their home market, and have permitted the manufacturers of Europe to monopolize the trade of the southern portion of this hemisphere. The development of our industries has, however, been so rapid, and the capacity of production has so multiplied by the invention of labor-saving machinery, that the time has now come when they must seek foreign markets for their surplus and must adopt the same methods which have been successfully used by their rivals in Europe. The manufacturers of Europe, by a close study of the wants and tastes of the people, and by long experience, have become familiar with the peculiarities of this trade and have turned their attention with great assiduity to the means of producing such objects and arranging them in such forms as would meet the requirements of Latin-American buyers. The merchants and manufacturers of the United States may well take a lesson from the experience of these rivals and bend their efforts towards securing this trade.

Of the peculiarities of the southern markets most manufacturers in this country know nothing, because they have never studied them; and millions of dollars worth of trade goes annually to Europe because the merchants of the United States do not seek the market or endeavor to produce the goods that are required. The demands are imperative and are governed by conditions that can not be altered. Our merchants, to command this trade, must be prepared to furnish in quality, design, measurement, and package exactly what is required, and this can be done only by studying the customs, needs, tastes, and prejudices of the buyers.

The communities of Latin America demand goods such as convenience and fancy have made desirable to them. They wish cotton in shorter pieces than our manufacturers turn out, and colored goods of brighter patterns. The American mills first manufacture and then solicit orders. European manufacturers reverse this method. Our manufacturers incline to make up designs of their own, suitable for the markets of the United States, and insist upon furnishing the same for the tropical market. An order for specific goods is rarely ever executed, but is nearly always filled from the stock on hand, with the result that the American manufacturers do not receive and seem not to care for a second order. If they would be successful in

securing this Latin-American trade, merchants and manufacturers must be ready to produce or to procure the kinds of goods that are ordered by their buyers, and their promises made in this behalf must be adhered to with fidelity. The principle which seems to have actuated so many American business men, with regard to the kind of articles intended for this foreign trade, of "take it as we send it or leave it alone," must be uprooted and overturned before there will be any continuous or extensive commerce established with Latin-American countries. When our merchants shall study the quality and style of goods in demand, and become willing to exercise care and attention in the details of their manufacture, packing, baling, and shipment, then will be the golden opportunity for American manufacturers to control the enormous trade of the Latin-American countries now held by Europeans.

Consul-General Adamson, of Panama, reports:

The greatest objection in buying cotton goods in the United States, as stated by dealers here, is that the goods are too good; that the Panama buyer must take what the American manufacturer chooses to produce, and not what the buyer wants; that the English goods, made with a very large admixture of Surat cotton, but clayed and starched and calendered until they look even superior to the American article, are put up in pieces of uniform length and of greater variety of patterns in a package, which is so compressed as to greatly reduce its cubic measure and at the same time the cost of freight; that the packages are made to weigh just what the buyer wants them to weigh, and are so enveloped in double baling cloths and oiled paper as to make them waterproof.

One of the points particularly emphasized here is that they can have as few as 10 pieces of 30 yards each printed in England, with any pattern they may select from sample cards, and of the precise quality and width of cloth they may choose.

A commission house in Manchester, for instance, sends to its constituents in South America and Central America sample cards of the patterns of prints they are prepared to make, and with them they also send samples of the various cloths on which they will print those patterns, the price of the cloth, of course, depending on its quality, and the price of printing on the more or less expensive nature of the pattern chosen. The dealer here is not bound to take a case containing 60 pieces of one pattern of prints, in four slightly different colors of figure and the assortment arbitrarily made at the will of the manufacturer, and of pieces of irregular lengths; but he can have the highest-priced pattern printed on the lowest-priced cloth, and as few as 10 pieces of 30 yards each of any pattern. He can order the substitution of one color for another in a pattern of several colors, to make it gayer or more quiet in style, or he may send a pattern he has found in another class of goods. Thus, a dealer here found on a red cotton handkerchief a pattern that he thought would suit his trade with the Darien Indians, and had it printed on calicoes for that market, to his great profit.

2. The unsatisfactory method of packing goods.

As the tariff in all the countries under native government is levied upon the gross weight of imports, it is of vital importance that they should be lightly packed. As they undergo a great deal of rough handling, it is essential that they be packed securely; and as the goods go, for the most part, to a humid, tropical climate, mold, rust, and

dampness must be guarded against by waterproof envelopes. If the destination is not beyond the seacoast, the packages may be large, but if they are to go into the interior, they will be transported on the backs of men and mules, except in the rare instances where there are railroads. There are principal depositories for imported goods at the seacoast whence the distribution takes place, and from these places orders are shipped to all parts of the interior and by every conceivable means of transport, which must also be considered. Most of the interior transportation in the southern countries is furnished by mules and men and in Peru and Bolivia by llamas. A mule can carry 250 pounds, but the weight must be equally divided upon either side of the saddle. A man can carry 125 pounds in a single package, and a llama a similar weight; and the goods should arrive at the port in such shape that they can be transported without repacking. In every case before shipping his goods the American manufacturer should ascertain precisely how they are to be transported and should pack accordingly. Packages should be made up to suit the mode of conveyance, attention being given to weights and sizes and wrappings, which must invariably be of waterproof material, and the shipper should never depart from his instructions in the matter of packages. Bales of small packages, such as underclothing, socks, trousers, etc., should be iron-bound on sides and ends, and made as tight as possible. The package should be neat and attractive and plainly labeled. Where boxes are made they should be new and well nailed. To pack goods for export in the lightest possible manner and at the the same time securely against damage in transit is an art in which the European manufacturers excel, but which the United States manufacturers seem never to have studied.

3. Longer credit given by European houses.

There is unanimity of testimony that the merchants of Europe give longer credit to Latin-American buyers than our merchants have thus far allowed, and this is another reason why they obtain a larger portion of the trade.

Latin-American merchants do not receive their payments steadily at frequent intervals, as they only come when crops or herds are sold, for we find it almost invariable that the people in agricultural communities prefer to purchase on credit rather than for cash.

A credit system is also rendered necessary by the great distance of the purchasers from the source of their supplies and the imperfect means of communication in the countries themselves. The wholesale dealer sells to a retail dealer, who is governed in his payment not only by his cash receipts but by his opportunities of remitting his indebtedness. If he lives remote from a railroad, it may be many months before he has an opportunity. The importers also have to make up their orders months before they receive their goods.

These and other causes have conduced to make a credit system the universal business habit of Latin America. It is practically impossible for the wholesale dealer to sell many goods for cash. His regular customer, whether he live in the city or at a distance, is more or less his debtor. When he comes to purchase he may bring money, but it is only to pay up in full or in part the old account. What he buys is on time. If he lives near by, he begins to pay in fifteen days. If communication is difficult, he takes much longer. In Honduras the extent of credit is estimated at two-thirds of the volume of business, and this may be considered a fair estimate for Venezuela, Colombia, Argentina, and Peru, while in Brazil, Haiti, and Porto Rico it is somewhat more and in Uruguay and Costa Rica slightly less.

The demand for credit has been met with accommodation by the merchants of Europe, who allow the buyers from six months' to a year's credit. Further systems have been devised for convenience. "For instance," says a writer on the subject, "a merchant in England receives orders from one or more South American merchants aggregating a large sum. The English merchant presents these orders to his bank, to whom, as a rule, the financial standing and business integrity of the South American importers are known, and arranges for the bank to carry the credit, the bank obtaining, in addition to the interest paid by the debtor merchants in South America, a percentage of the profits of the English merchant derived from the sale of the merchandise." From Argentina it is reported that "many houses in Buenos Ayres now have agents in Europe who, in consideration of the business put in their hands, give an open credit in proportion to the amount of business done."

Notwithstanding the fact of long credits being demanded, bankruptcies and failures are rare, and the system is reported as mutually advantageous.

4. Advantage of experienced salesmen, who must speak the language.

The first thing necessary to the capture of a new market is an agent to display goods and get orders. In Latin America such a man must speak the language of the country, or he is practically useless. If a North American, he must remember that he is dealing with people of a different race from his own, with different social and business habits and to which latter he must conform. The qualities that go to make up a successful traveling salesman in Latin America can only be obtained after that experience which grows out of residence and travel and in acquaintance with the country wherein his field of labor is to be located. Catalogues and circulars should accompany the agents, but by themselves they are of little or no use, especially if printed in the English language.

5. Object of the display by the Bureau of the American Republics at the World's Columbian Exposition.

A principal object of the Bureau of the American Republics in making its display at the World's Columbian Exposition was to furnish the United States merchants and manufacturers who might desire or propose to open a commerce with Mexico, Central or South America information which would enable them to compete in some degree with their European rivals. There was, therefore, included in the display a practical illustration of the requirements of the consumers in those countries as to the goods which might form the foundation of their commerce. In the formation of this exhibit the Bureau extended its researches in various parts of the world. The aid of all diplomatic and consular officers in foreign countries was invoked. Information was obtained from them, and some of them in Europe obtained and forwarded samples of the principal goods manufactured within their respective districts and intended for the commerce of Mexico, Central and South America. Reports were received from the following diplomatic and consular officers of the United States:

Austria:
Commercial Agent John B. Howe, of Reichenberg.
Belgium:
Consul George F. Lincoln, of Antwerp.
Consul George W. Roosevelt, of Brussels.
United Kingdom:
Consul F. H. Wingfall, of Leeds.
Consul Wood, of Dundee.
Consul Wallace Bruce, of Edinburgh.
France:
Consul Charles B. Trail, of Marseille.
Consul Edw. B. Fairfield, of Lyons.
Consul Hermel de Sallier-Dupin, of Nantes.
Germany:
Consul Daniel B. Hubbard, of Annaberg.
Consul-General Aulick Palmer, of Dresden.
Consul James S. Kellogg, of Stettin.
Argentine Republic:
Consul E. L. Baker, of Buenos Ayres.
Bolivia:
Minister T. H. Anderson.
Brazil:
Consul-General H. C. Armstrong and Minister E. H. Conger.
Consul James M. Ayers, of Para.
Consular Agent L. F. Da S. Santos, of Maranhão.
Colombia:
Consul Johnson Nickeus, of Barranquilla.
Vice-Consul Tracy Robinson, of Colon.
Consul Smith, of Carthagena.
Consul-General Adamson, of Panama.
Costa Rica:
Consul Beckford Mackey, of San Jose.

Ecuador:
Consul-General William B. Sorsby, of Guayaquil.
Mexico:
Consul Eugene O. Fechét, of Piedras Negras.
Consul John S. McCaughan, of Durango.
Consul James Viosca, of La Paz.
Consul Charles B. Richardson, of Matamoras.
Consul-General Sutton, of Nueva Laredo.
Consul A. J. Sampson, of Paso del Norte.
Consul Delos H. Smith, of Nogales.
Consul A. Lieberknecht, of Tampico.
Consul John Drayton, of Tuxpan.
Paraguay:
Consul Edmund Shaw, of Asuncion.
Peru:
Consul A. J. Daugherty, of Callao.
Chiclayo agency, by Consul A. J. Daugherty.
Salvador:
Vice Consul Guillermo J. Dawson, of San Salvador.
Uruguay:
Consul Frank D. Hill, of Montevideo.
Venezuela:
Consul E. H. Plumacher, of Maracaibo.
British colonies:
Consul Thomas J. McLain, jr., of Nassau, New Providence.
Consul Phillip Carroll, of Demerara, British Guiana.
Consul W. R. Estes, of Kingston, Jamaica.
Danish colonies:
Consular Agent Joseph L. Taylor, of St. Croix.
Consul Samuel B. Herne, of St. Thomas.
Dutch colonies:
Consul L. B. Smith, of Curacao.
Acting Consul W. Wyndham, of Paramaribo, Dutch Guiana.
Spanish colonies:
Commercial Agent D. M. Miller, of Sagua la Grande, Cuba.
Consul Lewin R. Stewart, of San Jose, Porto Rico.

Commercial samples were received from certain of these officers. These samples consisted of the actual articles prepared and packed at the manufacturer's place of export in the foreign country, and were taken from their stocks just as ready for shipment to these Latin-American countries; and these samples were displayed in the exhibit of the Bureau of the American Republics that they might afford an ocular demonstration to the American merchant or manufacturer how these goods were required by the Latin-American trade and how they were arranged and prepared in the European market in catering to this trade.

Consul-General Aulick Palmer, of Dresden, Germany, sent 60 packages, embracing everything entering into the commerce, from broadcloth to buttons and from furniture to ice machines. His memoranda in regard to broadcloth may be quoted as a sample of the descriptions which he gave accompanying each package.

No. 2. Broadcloth exported to Brazil, Chile, Peru, Bolivia, and Mexico.

Prices and width marked on each sample.

Broadcloth of superior quality for men is manufactured at Grossenhain and Bischofswerda, mostly in black, blue, brown, and bottle-green colors.

The width of this cloth is about 130 to 140 centimeters, and the finest quality is shipped to Guatemala, Lima, Rio Janeiro; the medium quality goes to Bolivia and Chile, and some to Peru and Mexico.

Consul A. G. Wood, of Dundee, Scotland, sent 94 samples of jute and linen goods manufactured in that city especially for the South American trade.

The consul at Belfast, Ireland, sent 230 samples of linens, etc., manufactured especially for the South American trade. All these exhibits were displayed, as before mentioned, in the Bureau of the American Republics at the Exposition.

COCOA AND CHOCOLATE.

BY

J. S. BRENNING.

COCOA AND CHOCOLATE.

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NATURAL HISTORY.

Cocoa, or more properly cacao, is a valuable dietary substance yielded by the seeds of the cacao tree, belonging to the genus Theobroma, of the natural order Sterculiaceæ.

The cacao tree is a beautiful object. It grows ordinarily to the height of from 18 to 24 feet; it has a cinnamon-colored bark, and its wood is white, porous, light, and brittle. Its round, gray branches bear large alternate leaves, from the avils of which spring red and yellow flowers.

This tree is a spontaneous growth in the forests of the Amazon and the Orinoco and is found at an elevation of even 1,200 feet. It grows similarly in Mexico, Guatemala, Nicaragua, and the neighboring countries, where it appears to have been introduced by the Indians before the European discovery of America.

M. de Candolle tells us, in his fine work on The Origin of Cultivated Plants, that when the first Europeans penetrated into the New World, the seeds of the cacao tree were sent up into the high regions of Mexico, where its culture is impossible. Their distribution was already begun and they ultimately became a common article of commerce.

This precious tree is now grown in all American countries with a favorable climate, particularly in the Antilles, Venezuela, Colombia, New Grenada, Equador, Brazil, and Guiana.

The cacao tree is delicate in cultivation. It requires a constant temperature of about 27 degrees, plenty of moisture, a rich soil, and protection from the sun. The plantations are generally situated in deep valleys, inaccessible to drought. In Equador the seed (or bean) is planted in the ground. In Venezuela it is sown in nurseries and transplanted at the end of six months. When the plantation is established in the midst of a forest, the trees which are too near are cut down and others manipulated whose foliage is abundant enough to afford a shelter to the young plants.

The soil for growing the cacao tree must be deep and rather heavy. It does not flourish in sandy or stony ground. If the plantation is in the open, trees are first grown to afford ample shelter. Those generally adopted are the banana tree, which shoots up with astonishing

rapidity; the citron, the anona, and the bucarre—trees with strong roots, vigorous growth, and thick-leaved branches, which continue to protect the cacao plant long after the banana tree has disappeared. Indian poesy calls the bucarre the mother of the cacao tree.' Flowers appear on the tree in the third year, but they are cut until it is 5 years old. From this time it bears seed, and up to 20 years and sometimes beyond it yields an abundant crop.

The Spanish conquest ruined the culture of the cacao tree in Mexico by forcing the natives to work in the gold mines. It spread, however, in South America, but all attempts have failed to acclimatize it in Europe.

The following are the principal varieties, which depend on climatic conditions and the nature of the soil: (1) The common cacao tree, grown in the Antilles and varying from 18 to 24 feet in height.. This attains to the largest dimensions; (2) the Guiana species, which does not exceed 15 feet; (3) the bicolored species, grown in Brazil and Colombia, and still smaller than the foregoing; (4) the elegant cacao tree of Para; (5) the forest species, which grows in Rio Negro; (6) the oval-leaved species, which appears to be the original of that cultivated in Mexico and producing the famous cacao soconusco or cocoa royal.

The produce of the cacao tree, gathered principally in June and December, is commonly known as the "pod." It varies from 10 to 20 ounces and comprises from 25 to 40 beans in five divisions surrounded with a red mucilaginous pulp of an agreeable acid flavor. When plucked the pods are gathered into a heap under sheds and left there for three days. They are then emptied, and the seeds are separated. It is these seeds (or beans) which constitute the alimentary part of the fruit—the cocoa. They are shaped like almonds, gently flattened and formed of two cotyledons, the one entering the other, separated by a slight skin and inclosed in a husk covered with long vascular fiber. This husk is of a dark color, although the bean is a clear brown, and sometimes violet or black. The beans, still surrounded with pulp, are dried in the sun and then heaped together to undergo fermentation, which is of great importance to their future quality.

THE COCOA LEGEND.

According to the Mexican legend, Quetzlcotl, the divine cultivator, brought from Paradise—where lived the first children of the sun—the seeds of the quacaholt, the tree of trees, and an object of veneration to the people whom it furnished with a food that was considered of celestial origin. It is thus that the grateful fancy of all nations has derived from Paradise the fruits that are the basis of their subsistence. From the highest antiquity the Mexicans regarded the cocoa bean as a providential food, attributing to it the most marvelous properties. They even used it as current money; the kountel equaling 400, the xiquipil 80,000, and the karga 240,000. The city of

Tabesco paid Montezuma an annual tribute of 2,000 xiquipils. The Mexicans roasted the cocoa bean, and consumed it in the form of soup, with a mixture of maize flour and a seasoning of red pepper. The consumption of this preparation was so frequent and universal that the Christian converts at Chiapa forsook the church when the bishop forbade them to take it during the time of divine service.

HISTORY OF COCOA.

The Spaniards, after the conquest of Mexico, having appreciated the remarkable qualities of cocoa, kept it entirely for their own use, and rigorously prohibited its exportation. About two centuries ago, however, cocoa crept into the court of Louis XIV. Queen Marie Therese loved it with Spanish ardor. Mademoiselle Montpensier says that she took it secretly, having brought from Madrid a Spanish chambermaid (La Molina) who was an adept in the preparation of the delicious beverage. Madame de Sévigné seems to have shared this preference. Writing in February, 1671, she laments that Madame de Grignan, who had gone to Lyons, would not find a chocolate maker in that barbarous town.

Chaliou first established a cocoa shop in Paris, at the junction of the rue St. Honoré and the rue de l'Arbre Sec, a spot which is now occupied by a fountain. The faculty of medicine soon favored the new product, and Michael Dupont, a successful candidate for the degree of doctor, sustained in his thesis "The salutary uses of chocolate."

Chocolate houses appeared about the same time in London and became common a generation later, in the time of Addison and the Spectator. From Spain, early in the seventeenth century, the use of chocolate passed into Italy, being extended there by Antonio Carletti, of Florence, who lived a long while at the Antilles. Its use was common and its properties were familiar in Austria, for in 1624 Franciscus Rauch issued a pamphlet in which he recommended the interdiction of chocolate to monks, who would thus be saved from many extravagances. A Dutchman, Bontekoe, physician to the Great Elector William of Brandenburgh, wrote a treatise in 1679 on Tea, Coffee, and Chocolate, in which he highly praised the last of these productions.

After the death of Marie Thérèse, Louis XIV himself contracted a strong liking for chocolate. It was served liberally to his guests on reception days, but as chocolate cost 6 francs per pound the frugal Maintenon put an end to this prodigality. On the death of Louis chocolate was once more patronized at court. The Regent took it daily, it was served at his levees, and its use rapidly spread downward into all classes of society.

The demand for this article has steadily increased since then in every civilized country. There are many manufacturers of chocolate and cocoa in various parts of the world, but the development of this industry is chiefly due to the enterprise of two world-famous firms—

Menier in France and Van Houten in Holland. The history of these two houses is the history of cocoa in the present century.

Up to sixty years ago the demand for the article was limited and the price was prohibitive. Its sale was restricted to chemists and confectioners who sold it in the form of bonbons and sweetmeats. The method of its production was most primitive. The pulverization was done by hand—a process at once slow and repulsive, and the article as offered for consumption was largely adulterated with foreign matter. Things were in this state when cocoa entered upon a new area, thanks to Menier and Van Houten, who, independently of each other, from 1825 to 1828, made a great economical progress in its manufacture and placed it within the reach of all classes—this wholesome aliment, as Linnæus called its principal ingredient, Theobroma, the food of the gods.

CHOCOLATE.

M. Menier founded in France an establishment for the manufacture of pharmaceutical products in general, but principally of those which could be reduced to an impalpable powder. It was the first factory in France where mechanical pulverization was conducted on a large scale. The manufacture of chocolate, which was at first an accessory, eventually became the chief branch of the business. In 1832 the Society for the Promotion of National Industries awarded a gold medal to M. Menier in recognition of the remarkable simplicity of his process and the general conduct of his factory. In 1853 the factory was greatly enlarged and is now the foremost producer of chocolate in the world, although many rival establishments have sprung into existence.

Chocolate is a mixture of cocoa and foreign matters. Each country has its formula of production. Sometimes starch is added; sometimes only sugar and aromatics.

There is no law regulating the manufacture, and unfortunately the manufacturers often take too much advantage of this liberty.

It occurred to M. Van Houten, in Holland, cocoa might be supplied in a form preferable to that of chocolate without the addition of foreign matter, and therefore in a state of higher concentration and superior digestibility. It is to this idea and to M. Van Houten's researches and experiments that we are indebted for the cocoa powder, of which he was the real inventor and for the manufacture of which he was granted a patent in 1828. The sales of this new product gradually extended, but its merits have become widely appreciated only during the last twenty-five years. It is now known all over the world, and although each nation has its own cocoa factories Van Houten's is still by far the largest in existence.

Cocoa has these advantages over chocolate: Being in powder, its preparation is easy and rapid. Boiling water poured over a spoonful of it makes in an instant a nourishing beverage, which is ready to the

hand of the traveler, the tourist, the soldier, etc., while chololate is made up in cakes which require to be scraped down, boiled, and "milled," or frothed, before it is ready for drinking. Cocoa has no mixture of sugar, and can be taken by persons who must abstain from chocolate. The reduction of the natural fat renders it still more digestible, besides increasing the relative proportion of the azotoids and alkaloids, and thus improving its tonic and nutritive properties.

M. Charles Girard, the distinguished head of the municipal laboratory of Paris, writing in the great encyclopedia edited by M. Camille Dreyfus, after observing that cocoa is rarely consumed alone, but is usually mixed with other substances, such as sugar and arrowroot, when it is called chocolate, remarks that these additions are made for the more especial object of grinding the cocoa bean perfectly. "If recourse be not had to this method," he says, "a portion of the butter must be extracted. Cocoas thus relieved of fat," he adds, "are the object of an important trade in Holland and in England and are designated 'cocoa powder,' 'Dutch cocoa,' 'soluble cocoa,' etc. About one-half of the fatty matter is extracted, and the paste which remains, containing no more than 30 per cent of butter, is easily reduced to a fine powder. These cocoas," he continues, "from which the fat has been extracted, are evidently richer in nutritive and mineral elements and are particularly suitable to those persons with whom too great a proportion of the fatty matter disagrees."

These advantages of cocoa were bound to alarm these chocolate manufacturers when both articles were offered to the same class of consumers. Some of them have accepted the situation and taken to the manufacture and sale of cocoa powder. The most powerful among them, however, have declared war against the rival commodity, and, instead of carrying on a fair industrial competition, they resort to insinuations and calumnies.

Taking advantage of the public want of technical information, they even compare the partial extraction of fat with the skimming of milk, which is simply ridiculous. Milk contains only 4 per cent of butter, while cocoa in its natural state contains 50 per cent. To extract 2 or 3 per cent from the former is to impoverish it; to extract 20 per cent from the latter is to eliminate a great excess. The cocoa thus treated is rendered more digestible and at the same time relatively richer in its more nutritious elements. It is brought, in fact, to the normal condition of the perfect foods with respect to the proportions of albumen, fat, and sugar. Here, indeed, as elsewhere, there is "an art which adds to nature," although over it all there is "an art which nature makes," inasmuch as it is from her storehouse that science gathers the means of heightening the value or the beauty of her spontaneous productions.

CHOCOLATE AND COCOA MANUFACTURE.

Many improvements have been effected during the last thirty or forty years in the machinery for manufacturing cocoa and chocolate. The present method differs greatly from that of former times. Not to speak of the primitive fashion of the Tolteks and Aztecs, which still linger among the Spaniards and Mexicans, history informs us that in the first methods with any pretension to science the cocoa and sugar were mixed by men who worked upon their knees, so that few industries were so arduous or so injurious to health. In 1732 Dubisson invented a table which permitted the men to do their work standing. This was a stone with two inclined planes, under which were pots of glowing coal, the heat being sufficient to make the cocoa mass into a smooth paste. The substance was then pounded in a cast-iron mortar, both mortar and pestle being heated beforehand. One man could in this way make 14 pounds daily. Twice this quantity was placed at a time on the above stone table and slowly kneaded with the requisite quantity of sugar by means of an iron hand roller. This mixture was heated again on a stove and then cast into molds.

In 1776 Doret invented a water-power machine by which hand work was entirely superseded. Doret received a recognition from the Government on the proposal of the faculty of medicine at Paris, with permission to call his works the "Fabrique Royale."

Since 1778 all the operations have been performed by machinery except the sorting of the beans and the wrapping up of the cakes. Cocoa and chocolate up to a certain point go through the same process of manufacture. The first operation is the roasting of the beans in large revolving iron cylinders. (See fig. 1.) This improves the flavor and aroma, and passing afterwards through bruising rollers the husks are easily separated from the kernels. The broken beans are then assorted in rotating perforated drums, the thin light husks are blown away by fans in the winnowing machines (see fig. 2), and finally the hard cocoa "germs" are removed. The next operation is the grinding of the broken kernels between millstones (see fig. 3), from which the cocoa is delivered as a thin, uniform paste, the heat developed by the friction being sufficient to liquefy the cocoa butter. From this point the manufacture of cocoa and chocolate differs.

CHOCOLATE MANUFACTURE.

If chocolate is to be produced, the pasty mass is brought into the mixing mill, which consists of a large granite bedstone, revolving on a vertical spindle and two edge-running granite rollers, taking their motion from the revolving bedstone. The requisite quantity of sugar is added, and the mass is thoroughly mixed. But in order to complete the incorporation of the sugar with the cocoa the mixture has still to pass through crushing rollers, consisting of polished granite

FIG. 1.—ROASTING BEANS IN LARGE REVOLVING CYLINDERS.

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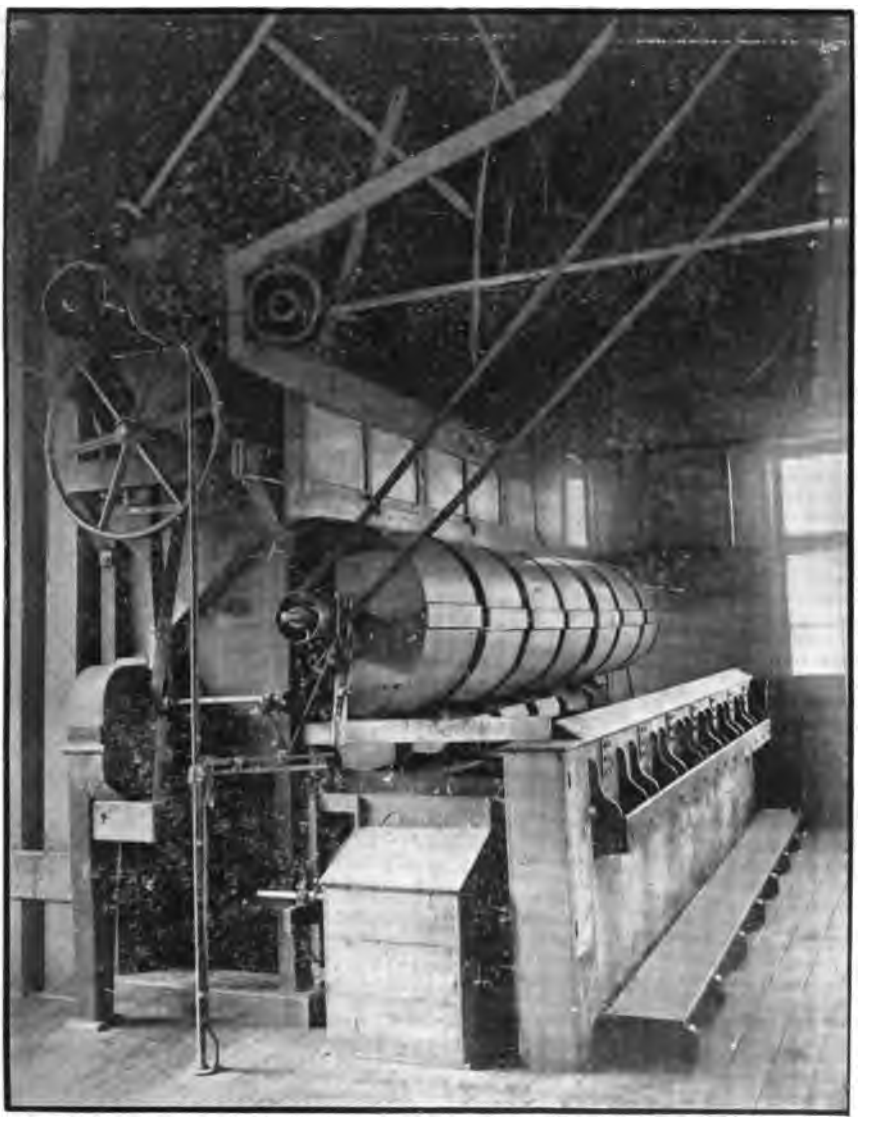

FIG. 2.—FANS IN WINNOWING MACHINES.

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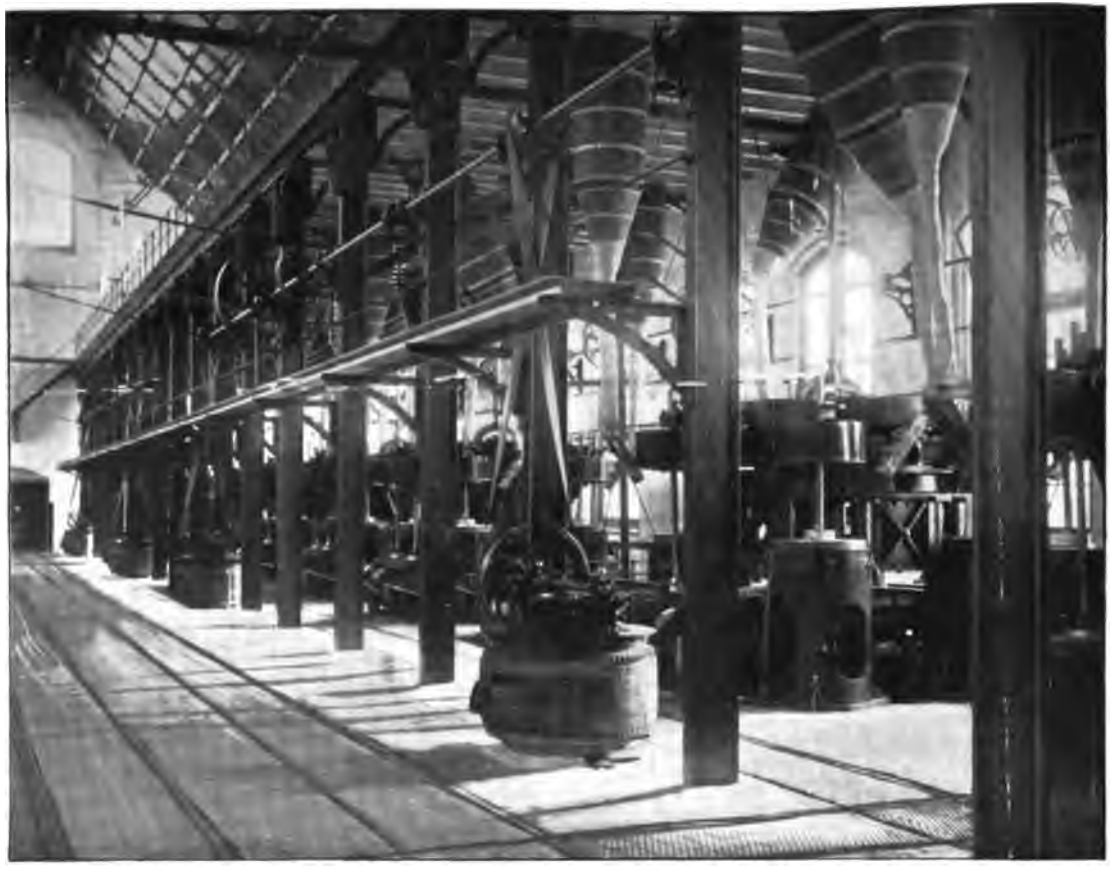

FIG. 3.—GRINDING THE BROKEN KERNELS.

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FIG. 10.—CRUSHING MILL WITH VERTICAL RUNNERS.

cylinders. On leaving these cylinders the mixture, which is now quite dry, is made pasty again in a heating room, and then, to secure the highest possible homogeneity, it is once more put in a mill with a single edge-running stone, which gives it the final kneading and of course makes it more fluid. Lastly, the air which has got mixed with the paste in these operations is eliminated by another machine, a cast-iron cylinder, in which an endless screw presses the paste through a small aperture. On leaving this machine the paste is cast in chocolate-cake molds, and any remaining air bubbles are eliminated by heavy shaking on a vibrating table. The molds are then cooled in a cellar and wrapped up for the market.

If cocoa powder is to be produced, the paste running from the millstones (fig. 3) is put into bags and subjected to powerful hydraulic pressure in order to remove a portion of the cocoa butter. The fat exudes slowly, leaving behind a solid, compact cake, which only requires to be broken up and finely powdered. This is effected by a crushing mill with vertical runners (see fig. 10), and the powder is finally passed through silk bolting sieves. This cocoa powder is generally put up in tins, with labels bearing the manufacturer's name. Chocolates for eating are prepared with large quantities of sugar and various flavoring substances, and form elegant and readily saleable confections.

COLONIAL AND REVOLUTIONARY OBJECTS.

BY

ANNE HOLLINGSWORTH WHARTON, JUDGE.

COLONIAL AND REVOLUTIONARY OBJECTS.

By ANNE HOLLINGSWORTH WHARTON, *Judge.*

In examining the colonial and revolutionary objects in the Government alcove, and those assigned to me elsewhere, several considerations have influenced me in giving my opinion as to whether or not these collections deserved an award. First, their historical importance and value, in consequence of age or rarity; second, their importance as illustrative of the life, manners, thought, and culture in the period to which they belonged, and also as marking the progress of art, science, manufactures, and the arts of domestic life; third, their intrinsic value, as in the case of original documents, and of family heirlooms, plate, watches, etc.; fourth, their educational importance.

Upon two of these considerations, the second and the fourth, I would base this report. A great exhibition like that at Chicago is primarily an educational factor, hence the value of the historical exhibits is to be gauged chiefly by their educational influence. This influence, I take it, was greatly enhanced by the full and interesting exhibit of objects illustrative of prehistoric life to be found in the department of ethnology and archæology, which with the Spanish-American objects gathered in the monastery of La Rábida, and with the numerous relics collected in the department of the California building, linked the prehistoric American life with the early colonial life so perfectly that the student of American history could read the birth and progress of the United States in a series of object lessons.

The story of La Rábida, with its treasures of maps and manuscripts loaned by the Vatican, its original letters by Columbus and others of his time, and its paintings, which, whatever their merits as works of art, fulfilled their mission of presenting the history of the Spanish discovery to many to whom books would appeal in vain, will be told by one who well understands the importance of such teaching.

The value of the California historical exhibit should be emphasized because it was overlooked by many, perhaps on account of its location, and because it supplies a needed link between very early times and the preseut. This exhibit occupied the entire southern end of the gallery of the California State building, and was under the care of Mrs. Mary E. Hart, secretary of the Southern California Scientific Association, to whose care and judgment the systematic and attractive arrangements of the exhibit were largely due. This department was divided into three groups of exhibits representing three eras in the

development of California—the Aboriginal era, the Mission era, and the Pioneer era. The first of these contained numerous objects illustrative of the customs of the aboriginal Indians of California, such as musical instruments, articles of dress, implements for securing game, a case showing various foods and the crude manner of preparing them, and food baskets of various kinds. Some of the latter, especially the cooking baskets made of the root fibers of grass, evidenced considerable skill and ingenuity among the natives in weaving and braiding, and besides being very strong are perfectly water-tight.

The Mission era exhibit represented the advent of the Mission Fathers and their influence upon the life and customs of the natives. Here were a number of paintings by Indian artists, and the famous Ford pictures from the art collection of Santa Barbara, showing the architecture of twenty-four mission houses in various sections, while a beautiful model of the Mission of San Luis Rey, by Don Antonio and Donna Mariana Coronel, gives a fair idea of the effect and proportions of this Spanish Mission at Los Angeles. The cloister, the tower, and other beautiful architectural features were here represented, all of which appeared on a larger scale in the California State building, which was modeled after three of the early mission houses, the San Luis Rey, the Santa Barbara, and the San Capistrano.

The adobe tiles used in building the old Spanish California houses were exhibited, carved objects made by Indian converts, and a series of pictures representing the Stations of the Cross, painted by the natives from such crude colors as were within their reach. These paintings are especially interesting as illustrating the influence of European civilization and thought upon the mind of the aborigines of America.

A song book, with music, used by the Santa Cruz Indians was also shown, and a curious and roughly constructed wheel-chime used in the Mission service of San Juan Capistrano, which had an interest as dating from the year of the Declaration of American Independence.

Some personal belongings of the Spanish governors and their families, garments ornamented with fine needlework and embroidery, and implements used by them, evinced the more advanced civilization of the Spaniard, while his native cruelty grafted upon Indian life was emphasized by the arena for the bull fight, built within the mission inclosure and within the sound of its chimes and hymns.

The Pioneer era contained numerous documents, including certificates of membership to various pioneer associations, among which may be mentioned the certificate of membership of William Tecumseh Sherman to the Society of California Pioneers, the Marshall relics, paintings, photographs, etc.

A number of interesting relics connecting the earlier Spanish colonial life with the later English, French, Swedish, and Dutch colonial, were to be found in the Louisiana State building, where among other

valuable manuscrips was the original order from Louis XIV for the settling of Louisiana and driving back the Indians, issued at Fontainbleau, April 3, 1718, also later orders to Perier and Vaudreuil

Here also was the appointment of Charles of Spain to Don Estevan de Gayerré, naming him royal auditor and comptroller for Louisiana in 1766, while upon the walls were paintings of the handsome Don and Donna Estevan de Gayerré.[1]

A number of beautiful pieces of china, old chairs, sofas, and other articles of furniture and some fine paintings were to be found in this collection, once the property of wealthy families of Louisiana, which served to illustrate the style of living among such families in that State in early days.

A sword of General Jackson's, and sword and sash of Gen. J. B. Planché, all worn at the battle of New Orleans, and relics of the war of 1812 and of the Mexican war, were to be found in this collection.

Interesting links connecting early life upon the continent with later colonial life and pioneer Western life were to be found in the Wisconsin historical exhibit and in that of the State of Ohio, both to be found in the gallery of the department of ethnology and archæology. Here were numerous objects connected with Indian life in the Northwest, and, not the least valuable, a number illustrating the earliest contact with white settlers and the rules existing between them.

Commendatory letters and commissions given to Ottawa chiefs by Sir William Johnson, the Marquis Duquesne, and Henry Gladwin were to be found in the Wisconsin collection, and also certificates confirming several chiefs as grand chiefs in 1778, and a certificate to Sarah Montour, better known to history as Madame Montour, of a contract of land on the Mohawk, near Fort Stannix, signed by chiefs and sachems of the Oneidas, 1793, signed with names and marks.

The Ohio settlement and early pioneer life were admirably illustrated by a model of the Adventure Galley, which brought the pioneers to Marietta. This model, made from one of the plates of the original galley, was shown in connection with a model of Campus Martius.

The first milestone used in Ohio, with a large collection of implements of husbandry and domestic use.

These last were so well chosen and arranged that they elicited much interest and some reminiscences of early life from older visitors from

[1] Don Estevan de Gayerré, the contador, or royal auditor and comptroller, was a younger son of a patrician house of Navarre in Spain. After serving in the Spanish army with distinction and holding positions of high trust in the Government, he was on the 10th of June, 1765, appointed by the King of Spain contador principial, ministerio de guerra y real hacienda. From numerous testimonials it appeared that this nobleman possessed in an eminent degree the traits of character which have always distinguished the noble race of mountaineers from whom he was descended.

rural districts. One of these latter, an old farmer, stood before a flax-brake knife and hackle, and recalled, for the edification of his children, how he wounded his hand with just such a hackle the day before his wedding, and had to be married with his hand tied up in consequence.

The only way in which the later colonial and revolutionary exhibits collected in the rotunda in the Government building could be fairly considered was by studying them in connection with those in the different statehouses. Many of these represented interesting colonial buildings, as in the case of the Massachusetts, Pennsylvania, New Jersey, and Virginia statehouses, which thus impressed the style of these historic buildings upon the minds of many who had never been able to see the originals. To those who have been reared within a short distance of Faneuil Hall in Boston or the statehouse in Philadelphia, both replete with interesting memorials of the past, it may seem a small matter to have been able to look upon some chair or table brought over in the *Mayflower*, or upon the watch that lay upon the table in Independence Hall while the Declaration was signed, or upon the inkstand into which the Fathers of the Republic dipped their pens upon that momentous occasion; yet no person could spend much time in the different State buildings and in the Government building without being impressed with the deep interest felt in these colonial and revolutionary relics. The number of people who were always to be found around the cases in the rotunda of the Government building and in the exhibit of the Department of State, where were gathered together letters and journals covering the most important periods of our history, battle flags, swords, and numerous relics, the many questions asked of the custodians and the expressions of wonder and delight heard upon all sides, witnessed to the keen interest felt in viewing these objects and to also their importance as educational factors. The great men and noble women of the past became more real to the children of the nation when they looked upon articles that once belonged to them, letters and journals written by them, and objects used daily in their homes illustrating their personal habits and characteristics.

Fathers brought their boys to show them the sword worn by Washington when he resigned his commission at Annapolis, December 23, 1783, the flag that floated over his headquarters, or the bold signature of John Hancock appended to the Declaration, or the first lightning rod of Franklin; while mothers drew the attention of their daughters to a pincushion made by Martha Washington, or a gown embroidered by Abigail Adams, to show them what neat stitches were set by these ladies of the olden time; or pausing before an elaborate piece of needlework representing an impossible Garden of Eden, in which Adam in the costume of Charles I, and Eve attired like a Watteau shepherdess recline upon a green bank, they marveled at the skill with which a last century New England maiden of 10 plied her busy needle.

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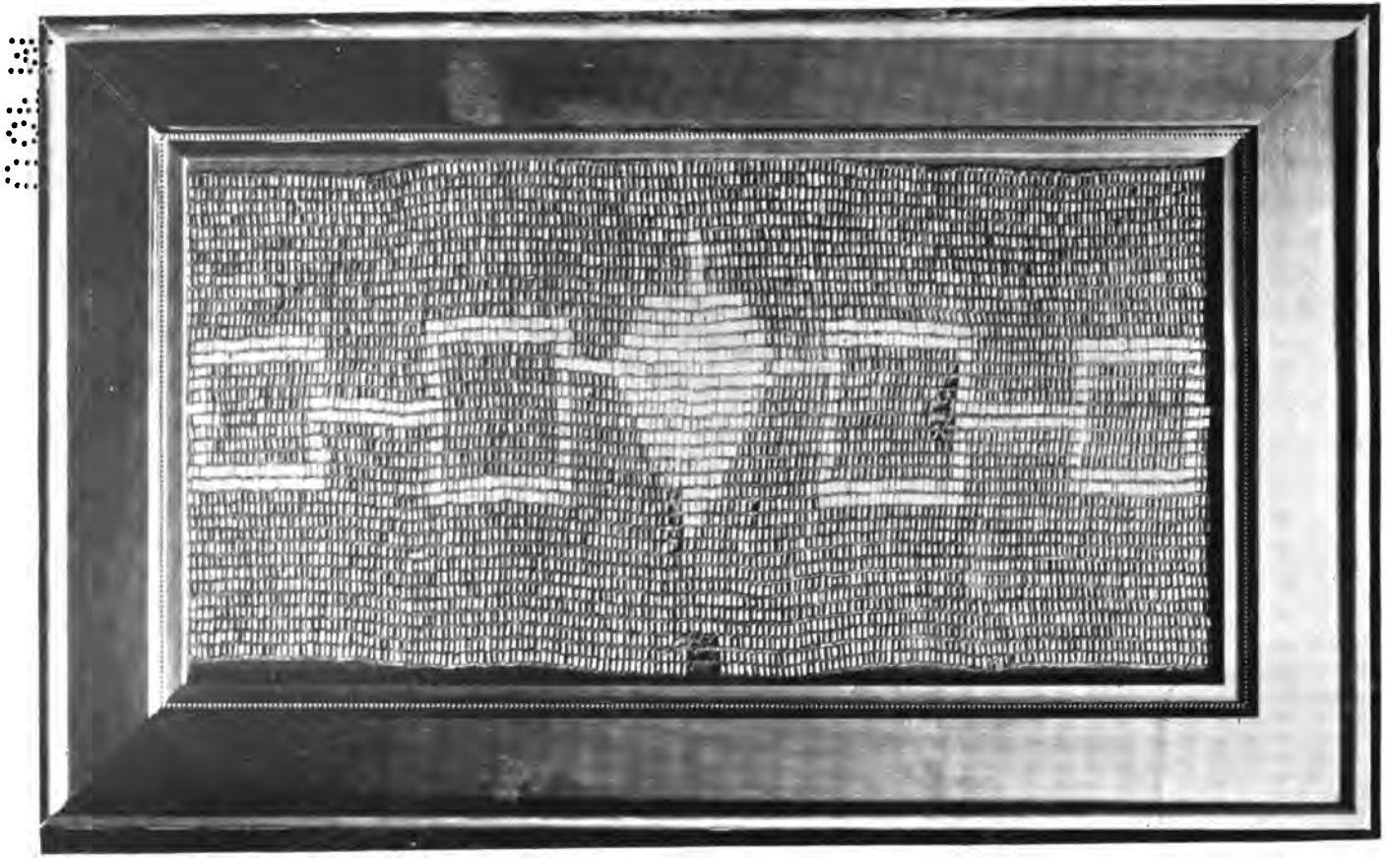

WAMPUM BELT.

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OLD HOLLAND SLEDGE.

All through these exhibits were to be found interesting objects connected with the advent of the European upon the continent, side by side with those of later colonial and revolutionary interest. One important function of these earlier relics was to draw attention to the much neglected fact that the American colonies can boast an eventful history prior to the stirring days of the revolution. In the New York case were two pieces of wampun, one to commemorate the advent of the white man upon the continent, and another to celebrate the federation of the Five Nations. The signification of this latter, a fine belt in excellent preservation, is thus explained by its owner, the Hon. John Boyd Thacher: The heart in the center represents the Onondaga tribe, Hiawatha having insisted on an agreement by which the headship of the league should abide with this nation. Through this heart are united the Oneidas and Mohawks and other tribes in the East, and the Cayugas, Senecas, and other nations on the West. The keeper of the Wampun, it was also stipulated, should belong to the Onondaga Nation.

This identical piece of wampum was made at the time to commemorate the union of the Five Nations, and was to that first American Union what our Constitution was and is to us. These relics, taken in connection with articles in household use among the early settlers—a tile from the first house in New Utrecht, Long Island, built in 1657, a Dutch Bible 256 years old, a communion service used at Flatlands as early as 1656, served to illustrate how closely the aboriginal life of the continent and the newer civilization were associated for many years—sometimes in peace and amity, but more frequently in hostility and bloodshed. This later and darker phase of the early history of New York was accentuated by a quaint old painting of the burning of Schenectady and a portrait of Deborah Glen, a survivor of this tragedy.[1] These pictures were in the New York Statehouse, where were to be seen old tankards, lamps, and candlesticks, a curious and handsome Dutch sledge for one person, which came from Holland in 1700, a "freedom suit" presented according to the custom of the time to Jonathan Sheldon at the close of his apprenticeship in 1778; a piece of a calico gown worn by Mrs. Jonathan Sheldon at her wedding in 1784, which cost $1 per yard; and to prove that the graces and adornments were not overlooked by women, even in troubled times, a lamp for heating crimping irons used over one hundred years ago was exhibited, also stays worn at the Washington Inaugural Ball by a lady of the Van Buren family.

Numerous relics of the powerful old patroon families were to be found in the New York collection; a seal of Philip Schuyler's; handsome silver from the Verplanck family; shoe buckles of Augustus

[1] Deborah Glen was one of the few survivors of the Schenectady massacre of February, 8, 1690, in which the attack of the savages was led by Lemoine de Sainte Helène and another French officer.

Van Cortlandt; a receipt signed by Killian Van Rensselaer; and a cannon that stood by the doorway of the old Van Rensselaer house in Albany, and was always discharged at the birth or death of a member of the Van Rensselaer family.

In the New York collections as in those of the other States an interesting contrast was presented between objects illustrative of extreme simplicity and the struggle of pioneer living, and certain luxuries in the line of household furniture and articles of dress imported and used by wealthier colonial families. The most noteworthy of these were a handsome Dutch demijohn ornamented with an appropriate picture of two men playing cards, a fine brass pestle and mortar, and various articles of silverware, while in the china collection were plates representing the birth of American Independence, the landing of Lafayette, Commodore Macdonough's victory, also a Washington memorial pitcher. This latter, made soon after the death of Washington, bore the following inscription upon its side, "Washington in Glory and America in tears."

In no State collection perhaps was this contrast between rude beginnings and established prosperity more marked than in that of Massachusetts. Here were to be found such traces of the life upon the continent as a copper censer made by the Franciscans who came over with Columbus a silver breastplate made by Miami Indians, and many traces of pioneer living; a knife worn by Miles Standish in 1630; a Judy lamp used in colonial days; a shoe and clog worn by Mrs. John Foye, of Boston, 1730; pattens 200 years old; a pitch pipe of the kind used in choirs before tuning forks came into vogue; a foot stove used in New England when churches were guiltless of fires; and a pair of clumsy little shoes worn by a New England baby who afterwards became aid-de-camp to General Washington. These objects were especially interesting when viewed in connection with the large collection of handsome furniture and the complete assortment of wearing apparel gathered together in the Massachusetts State Building. This house represented the fine old home of the Hon. John Hancock, and if, as was said by some visitors who remembered the original, it was somewhat handsomer and more ornate than the house that stood on Beacon street, Boston, in the early years of this century, it was in a general way an admirable reproduction in architecture and style.

On the right side of the doorway of this old Hancock mansion was a very beautiful room whose floor was laid in blue tiles; these, with a handsome fireplace with fire buckets hanging above it, heavy rafters, and deep-seated windows, gave the room an air of old-time comfort and elegance. On the left side of the hall was a room whose walls were lined with portraits of eminent sons of New England, and whose cases were filled with valuable and interesting documents and specimens of early colonial and provincial currency, including the old pine

VAN RENSSELAER CANNON.

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DUTCH DEMIJOHN.

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AMERICAN INDEPENDENCE AND THE LANDING OF LAFAYETTE.

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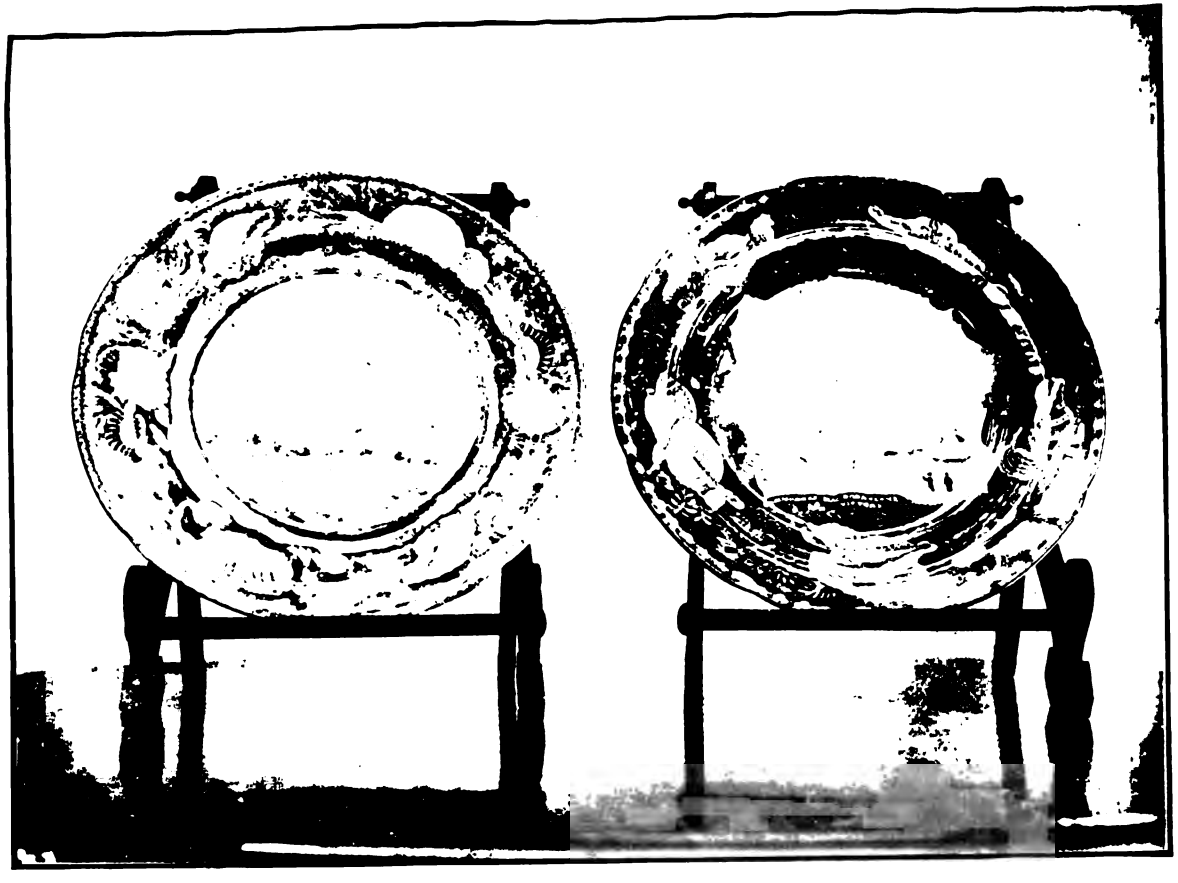

COMMODORE MACDONOUGH'S VICTORY.

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WASHINGTON MEMORIAL PITCHER.

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OLD HANCOCK HOUSE, BEACON STREET, BOSTON. ROOM ON RIGHT-HAND SIDE OF DOORWAY, FIRST FLOOR.

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OLD HANCOCK HOUSE, BEACON STREET, BOSTON.

OLD HANCOCK HOUSE, BEACON STREET, BOSTON. ROOM ON LEFT-HAND SIDE OF DOORWAY, FIRST FLOOR.

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ROOM IN HANCOCK HOUSE, SHOWING ADAMS'S FAMILY CRADLE.

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and oak tree shillings.[1] Many persons who had never had an opportunity of visiting Salem, and who may have begun to regard the witch tales of early New England, so remote from their own time, as of doubtful authority, were now able to gaze upon the original documents pertaining to this dark page of her history. Here were to be seen depositions of the Putnams and others before Magistrates Hawthorne and Curwin in Salem village, and indictments against Abigail Hobbs, of Topsfield, for covenanting with the devil, 1692.

These and many other manuscripts from the Essex Institute served in connection with the various objects associated with them to present an interesting object lesson upon the earlier life of New England. Further illustrations were to be found in a series of portraits and engravings of celebrated sons of Massachusetts, early and late, beginning with Winthrop and Bradstreet and other early governors, and ending with such eminent statesmen and writers as John Lathrop Motley, William Lloyd Garrison, George Cabot, James Russell Lowell, Wendell Phillips, Daniel Webster, J. G. Whittier, and Phillips Brooks. Autographs and letters of many of these men were found in connection with their portraits. Massachusetts certainly did much for the historical education of the children of the nation, for here, in addition to the many portraits exhibited, were pictures representing the architecture of the time, the lean-to roof and hip roof, such as that of Roger Williams, called "The Witch Home," because the first examination of witches was said to have been held in this old house, still pointed out to visitors to Salem.

Witch House in Salem.

Among special objects of interest in the Hancock house was a cradle in which five generations of the Adams family had been rocked, a mirror from the great house of Governor Hutchinson, the watch of Miles Standish, brought over in the *Mayflower*, and a fine desk, brought over early,[2] a corner cubbard used in England in 1568, a desk

[1] John Hull, a silversmith, and Robert Sanderson were in charge of printing when the pine-tree shillings were issued. The first date, 1652, was continued upon these shillings for thirty years. (Memorial History of Boston, I, 354.)

[2] To the desk above alluded to was attached the following interesting history:

"This bureau or writing desk belonged originally to John Drew, whose grandfather was Sir Richard Drew, who was knighted by Queen Elizabeth in 1589. He was born in England in 1642 and brought this bureau with him to Plymouth, where he joined the colonists in 1660. He established a home of his own in 1673 and lived, as his descendants also lived, through four generations in a house which

used by General Washington while occupying the Craigie home at Cambridge, an oak chest used in England early in the seventeenth century, and a clock made in Halifax, England, with the figures of Adam and Eve carved upon the door. In one of the beautiful rooms of the Hancock house was an original pencil sketch of Washington made by Wright, of New York, in 1790; some interesting pictures of Revolutionary scenes made by the famous Paul Revere, and a painting by Copley of the brother and sister of Governor Christopher Gore.

In some of the Massachusetts cases were handsome and elaborate gowns worn by ladies of the republican court and an interesting collection of costumes, coats, dresses, slippers, knee buckles, combs, fans, etc., reaching further back into colonial days.

Among other objects of interest in the Massachusetts collection were firearms carried in Queen Anne's war; a bullet mould used by women before the battle of Fort William Henry, 1758; the torch carried by Putnam into the cave; a cannon ball from the field of Lexington; and a Breeches Bible, which was printed in London in 1599 and brought over in the *Mayflower* in 1620, and has descended to its present owners, the Thayer branch of the family. The page containing records of family births and deaths has been kept by John Alden and his descendants down to the present day.

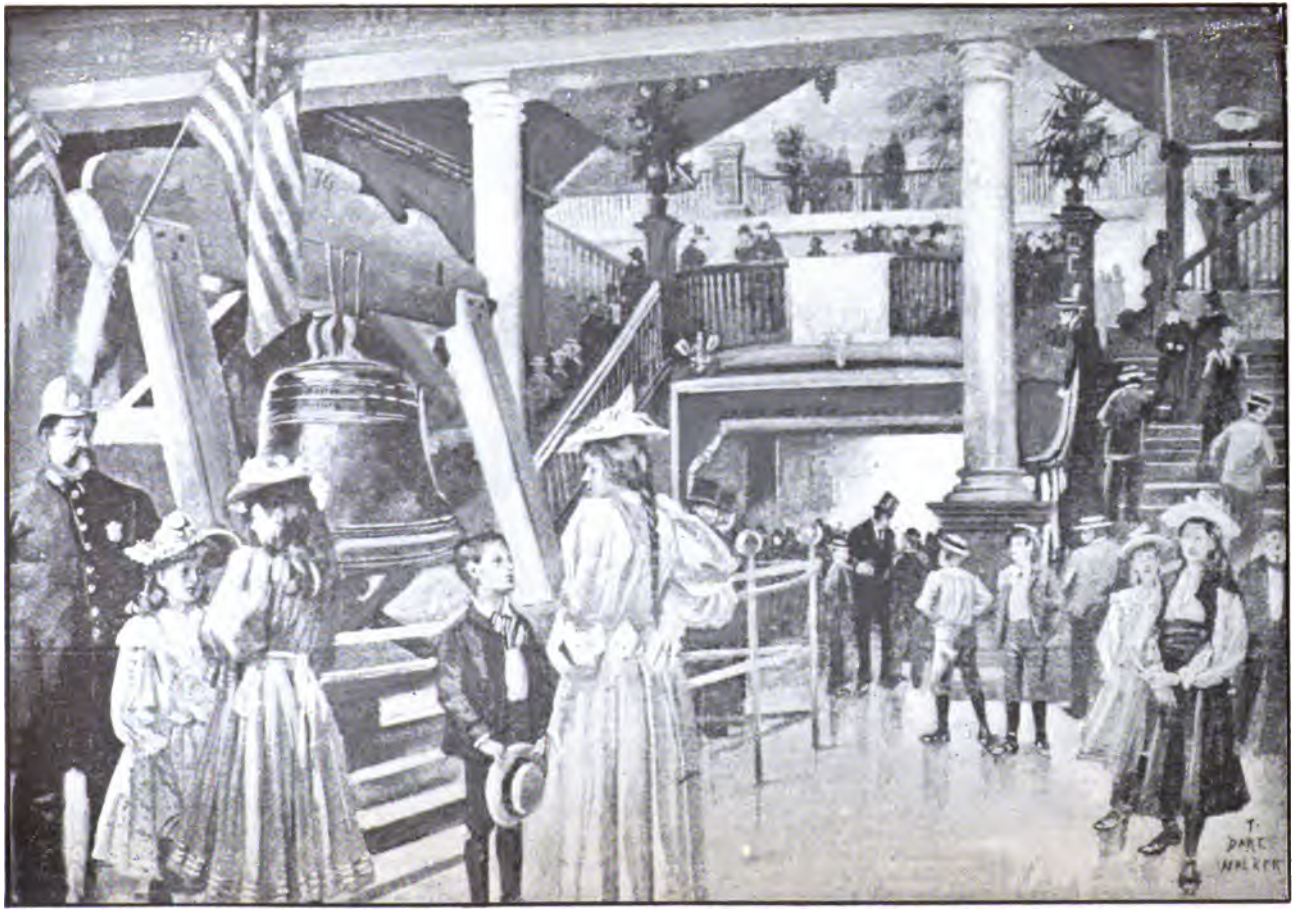
Although the collection of the State of Rhode Island in the case in the Government building seemed small when compared with those of some of the other States, it contained some objects of great historical value, as the original deed of 1642 for the town of Warwick, being the characteristic signature of the Chief Myantonomy and other Indians; also a manuscript letter of Roger Williams to Governor John Winthrop, dated November 6, 1651; a manuscript document upon the burning of the *Gaspee*, signed by Robert Auchmuty and others in 1773; and a broadside of 1767 upon abstaining from the use of tea and other imported articles.

Among objects of interest in the Rhode Island case were a handsome gold watch which belonged to Count Rochambeau; an inkstand of

stood on Coles Hill, about 250 feet from the brow of the hill overlooking Plymouth Rock. This writing bureau was handed down as one of the heirlooms of the family until it became the property of Winezer and Ma ar hia, who were the last Drews to own it. It then came to John Sturtyvant, who took care of the old men in their last days. It afterwards came into the possession of Winslow Brewster Standish, an antique furniture dealer, from whom the present owner purchased it.

"The writing desk was made before mahogany was introduced. It was veneered with red walnut, a wood now unknown, and the veneer was nearly the sixteenth of an inch thick, and still remains in place. It is believed to be the oldest piece of furniture of its kind once used by the early Pilgrim colonists in North America now existing. It must have been made in England in the early days of the seventeenth century, when Milton was writing his Il Penseroso in a country home, when Cromwell was serving in Parliament, when Stafford was the lord deputy of Ireland, and when Charles the First was trying to uphold the English monarchy."

LIBRARY



VIEW IN PENNSYLVANIA BUILDING.

Stephen Hopkins (signer); a handsome silver tea service, marked J. A. A., once the property of John and Abigail Adams; a silver loving cup of Hon. John Brown; large traveling watch and heavy spectacles of William Ellery; a candlestick and snuffers of General Greene; and a china plate made in France for Martha Washington, which is especially interesting, as it bears the names of the thirteen original States, with Vermont and Kentucky added. Some of these articles were handsome and all were representative of the life and customs of the times, as were many of the interesting relics gathered together in the Connecticut State building, where were rooms furnished in old-fashioned style, with corner cupboards taken out of old Connecticut homesteads, these filled with blue and mulberry china; quaint mirrors, chests of drawers, a wedding chest 300 years old, and bed hangings and curtains spun and embroidered by women among the early settlers. This house, like the log cabin in another part of the exhibition, illustrated a distinct phase of New England life. The interior of the Connecticut House represented the life and pursuits of towns, to which more luxuries came, while the log cabin, with its flax hackle, carding machine, spinning wheel, and festoons of dried fruits and vegetables, admirably represented the thrifty life of the pioneer in the small villages of the early settlement. Among the many interesting things in the Connecticut House were a chair brought from England by Richard Wayne, in 1785, which was sat upon by every President of the United States from Andrew Jackson to General Grant; a carved chest, brought to Hartford by Thomas Robinson, in 1640; watches, pistols, and swords of Jonathan Huntington, John Cotton, and Jonathan Trumbull; also a curious wooden settle with a high back to keep off the draught, which gave one a realizing sense of the struggles of our New England ancestors to keep their backs from freezing while their faces were warmed by the cheerful but delusive blaze of a wood fire.

Liberty Bell, showing crack.

Pennsylvania also sent some of her choicest treasures to Chicago, not least among them the old Liberty Bell, around which an incessant stream of people gathered, eager to see and to touch the precious relic, wondering how those words, a seeming prophecy of freedom, came to be placed upon its side as early as 1753:

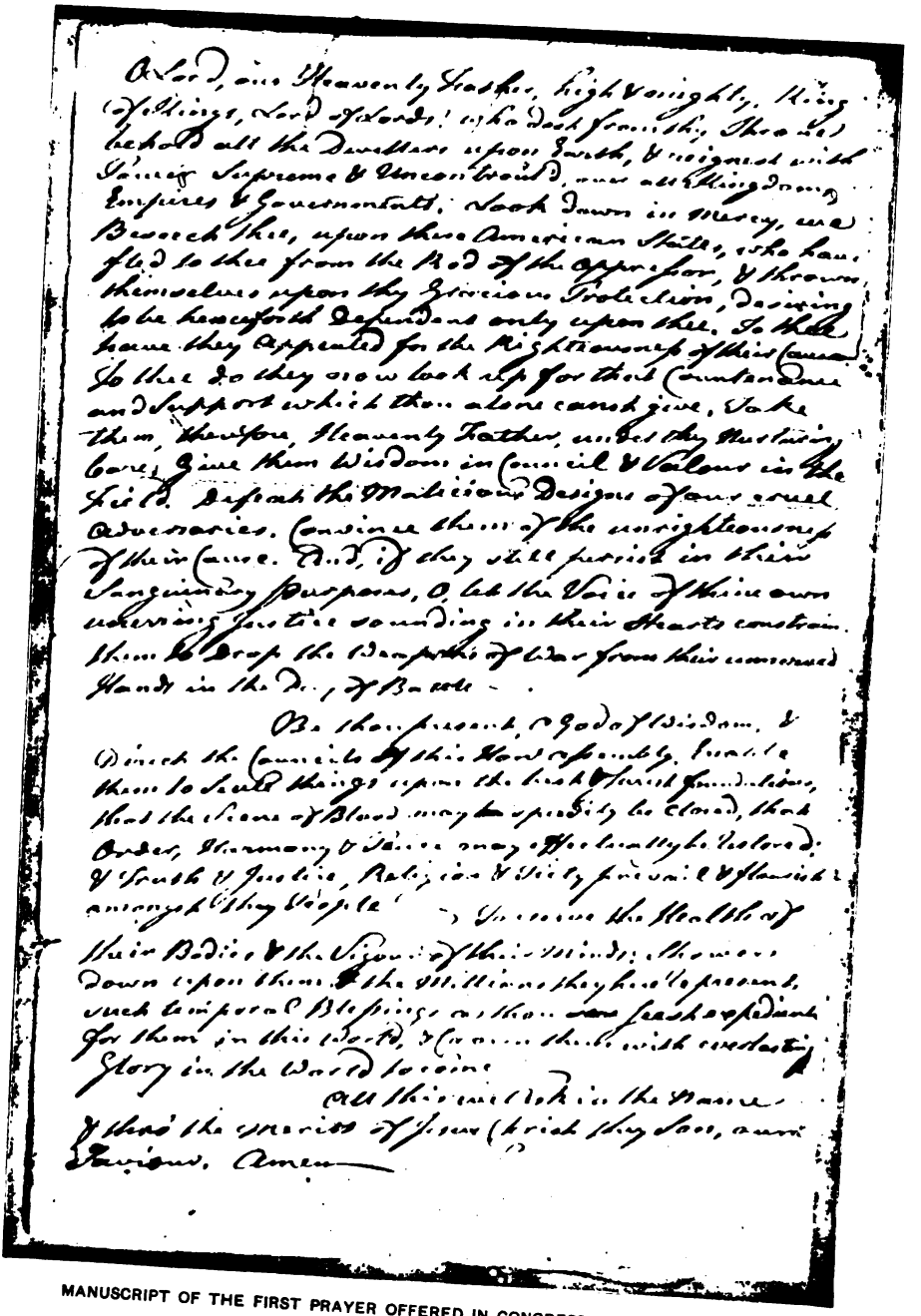
"Proclaim liberty throughout all the land, unto all the inhabitants thereof." Such questions were briefly and satisfactorily answered thus: After the bell arrived from England in August, 1752, and

before it was hung it was accidentally cracked, whereupon it was recast in Philadelphia by Pass & Stow, March, 1753, and the foregoing inscription placed upon its side. Although the bell was finished and hung in June, 1753, the most important event in its history is that on the Fourth of July, 1776, when it rang out its proclaim of the birth of a nation, upon the basis that all men are born free and equal

In 1777, when the American forces were obliged to evacuate Phila-

Removal of the bell to Allentown.

delphia, the bell was taken to Allentown, Pa., and placed in the care of the Zion Reformed Church, where it was concealed to prevent it falling into the hands of the British. At the close of the war it was returned to Philadelphia and continued in use until 1828, when it was so hung that it could be used upon state occasions. In 1836 it cracked while tolling for the death of Chief Justice Marshall, after which it was relegated to the position of an honored relic to which visitors to the Centennial of 1876 and to the World's Fair of 1893 have in turn

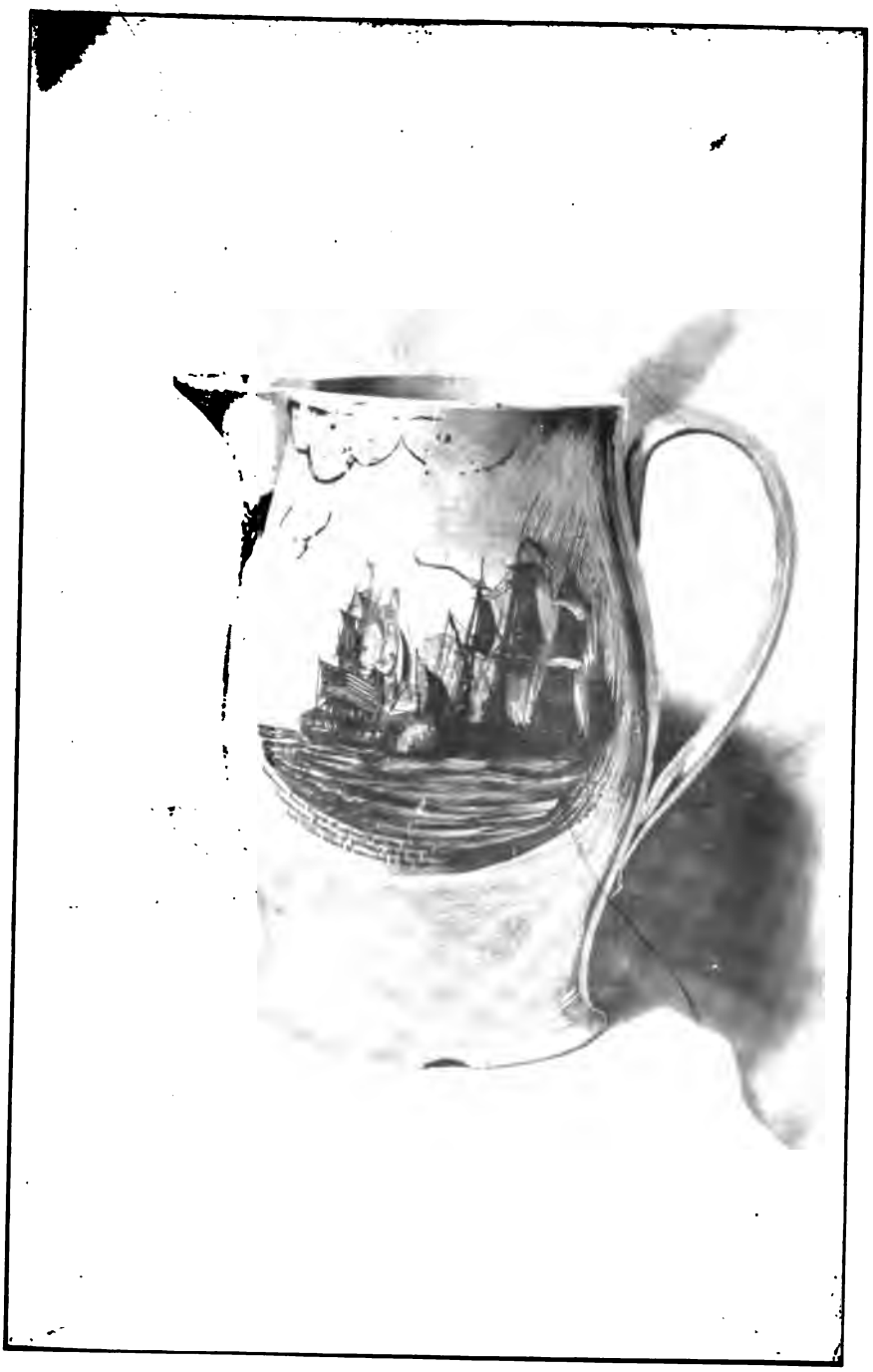


O Lord, our Heavenly Father, high & mighty, King of Kings, Lord of Lords! who dost from thy Throne behold all the Dwellers upon Earth, & reignest with Power Supreme & Uncontrould, over all Kingdoms, Empires & Governments. Look down in Mercy, we Beseech thee, upon these American States, who have fled to thee from the Rod of the Oppressor, & thrown themselves upon thy Gracious Protection, desiring to be henceforth Dependent only upon thee. To thee have they Appealed for the Righteousness of their Cause. To thee do they now look up for that Countenance and Support which thou alone canst give. Take them, therefore, Heavenly Father, under thy Nurturing Care; Give them Wisdom in Council & Valour in the Field. Defeat the Malicious Designs of our cruel Adversaries. Convince them of the unrighteousness of their Cause. And, if they still persist in their Sanguinary Purposes, O, let the Voice of thine own unerring Justice sounding in their Hearts constrain them to Drop the Weapons of War from their unnerved Hands in the Day of Battle.

Be thou present, O God of Wisdom, & Direct the Councils of this Hon. Assembly. Enable them to Seule things upon the best & surest foundations, that the Scene of Blood may be speedily be Closed, that Order, Harmony & Peace may effectually be restored: & Truth & Justice, Religion & Piety prevail & flourish amongst thy People. To receive the Health of their Bodies & the Vigour of their Minds; Shower down upon them & the Millions they here represent, such temporal Blessings as thou seest expedient for them in this World, & Crown them with everlasting Glory in the World to come.

All this we Ask in the Name & thro' the Merits of Jesus Christ thy Son, our Saviour. Amen.

MANUSCRIPT OF THE FIRST PRAYER OFFERED IN CONGRESS, BY BISHOP WHITE (JOHN HANCOCK'S WRITING).



NAVAL MEMORIAL PITCHER.

SILVER LAMP USED IN PHILADELPHIA DURING THE REVOLUTION, 1776.

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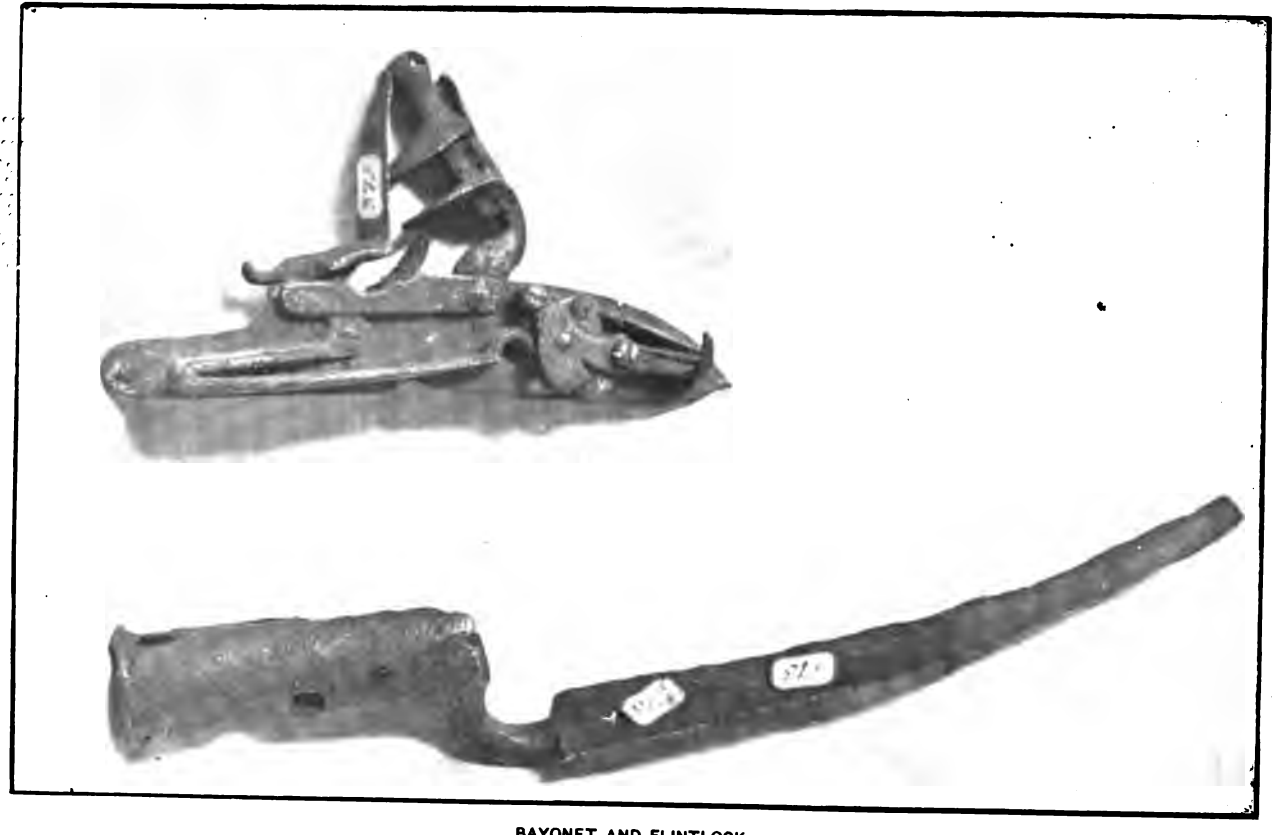

BAYONET AND FLINTLOCK.

CHINA PUNCH BOWL USED BY GEN. GEORGE WASHINGTON AND HIS OFFICERS DURING THE REVOLUTION.

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ALE MUG THAT BELONGED TO JOHN PAUL JONES.

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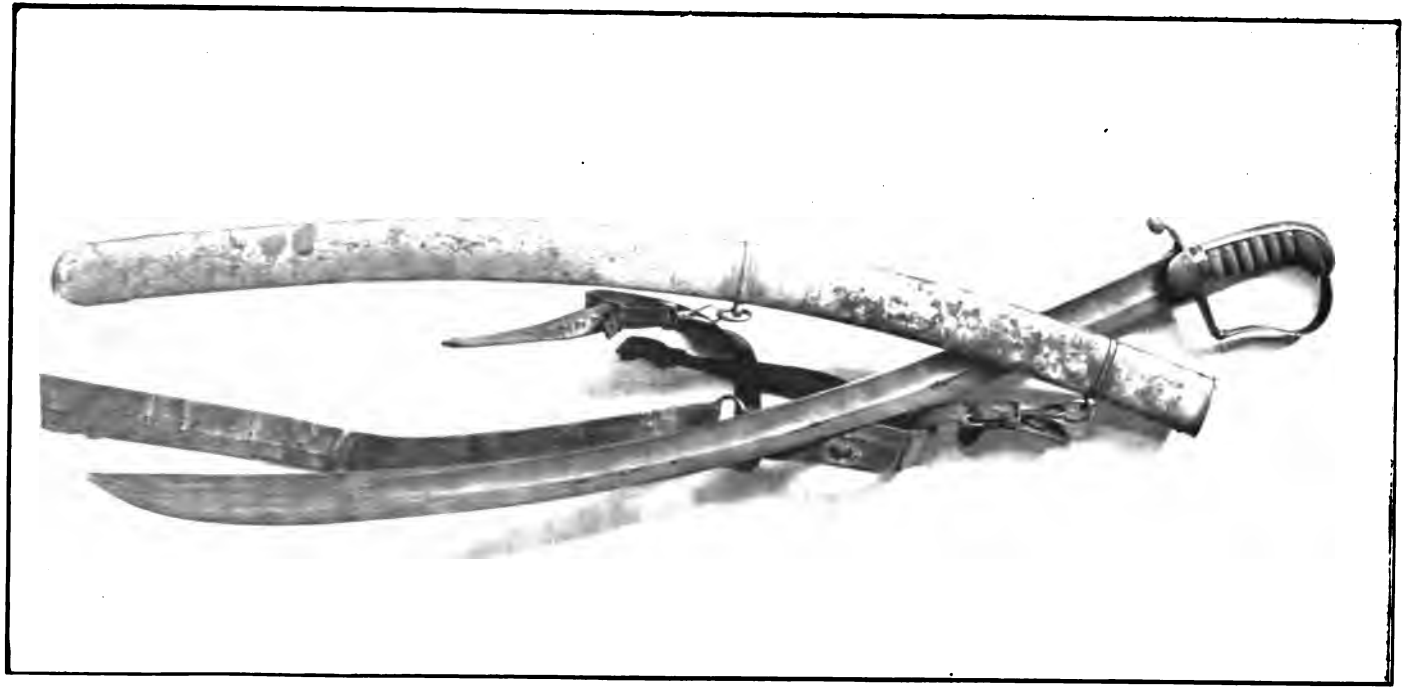
FORK AND SPOON USED AT VALLEY FORGE.



SWORD OF GEN. ANTHONY WAYNE.

paid their respects. The old bell now hangs in a special arch built for it upon its return from the Chicago Exposition—in the east room on the ground floor of Independence Hall, Philadelphia.

The relics in both the Pennsylvania State building and in the case in the rotunda of the Government building embraced such scope and variety that each one deserves special mention, possessing, as it does, unique historical interest. Among these were the watch and the suit of clothes worn by Charles Carroll of Carrollton when he signed the Declaration; the sword of General Anthony Wayne; a dress sword of John Hancock, first President of the American Congress, loaned by his great-grandnephew, Thomas Chase; a portrait of Bishop White, and in connection with it a manuscript of the first prayer offered in Congress, in the handwriting of John Hancock; a naval pitcher, bearing on one side the following inscription, beneath the lip of the pitcher:

"Our mountains are covered with Imperial Oak,
Whose Roots like our Liberties ages have nourished.
But long ere our Nation submits to the yoke,
Not a tree shall be left on the Field where it flourished.
Should Invasion impend, every Tree would descend
From the Hill tops they shaded, our shores to defend,
Ne'er shall the Sons of Columbia be Slaves
While the Earth bears a Plant, or the Sea rolls its Waves."
"Success to the Infant Navy of America!"

Upon the other side, under a picture of the naval engagement, is the following inscription:

"L'Insurgente, French frigate of 44 guns and 411 men, striking her colors to the American frigate, Constitution, Commodore Truxton, of 40 guns, after an action of an hour and a half, in which the former had 75 men killed and wounded, and the latter 1 killed and 3 wounded, Feb. 10, 1799."

A pewter platter marked "1600, from Thomas Chancellor to Frances Perot Ogden," which has come down through the Baileys, Guests, and Morrises. An old galoche or patten of leather and wood such as formerly took the place of our light and pliable rubbers; a silver lamp used in Philadelphia during the Revolution; a bayonet and flintlock taken from the frigate *Augusta*; which was sunk in the Delaware during the Revolution; china punch bowl used by Washington and his officers during the Revolution; a hymn book printed in Germantown in 1772; a silver tea caddy owned by Mrs. Richard Bache, daughter of Benjamin Franklin; a pair of white kid gloves worn by Thomas Roberts at his wedding in 1730, and since worn by six generations of his descendants on their wedding days; a clock brought from Scotland over two hundred years ago; a tortoise shell and gold snuffbox which belonged to Joseph Priestley; an ale mug which belongs to John Paul Jones; a fork and spoon from Valley Forge, and many other objects, once in daily use, that served the double purpose of recalling the

names and services of distinguished persons, while illustrating the life and customs of their times.

A Breeches Bible, in excellent preservation, recalled the curious derivation of the name which is said to have come from the following quaint translation of Genesis III, verse 7: "Then the eies of both of them were opened, and they knew that they were naked, and they sewed figge leaves together and made themselves breeches."

Of special historic interest was a musket ball from Braddock's field, 1755, a drum from the battle of Bunker Hill, a sword of Gen. Anthony Wayne, a Masonic apron worn by General Washington, and a letter from John Fitch (1788) asking exclusive rights upon the newly invented vessel to be propelled by steam.

In the Pennsylvania State building, whose exterior admirably represented Independence Hall in Philadelphia, the birthplace of our national and constitutional liberty, were gathered together a number of interesting objects. Here portraits of William Penn and of other governors of Pennsylvania and of such early mayors of Philadelphia as Matthew Clarkson, the Willings, Robert Wharton, Hillary Baker, and John Swift adorned the walls, while in the cases were to be found such valuable and interesting manuscripts as the Quitclaim Deed from James, Duke of York and Albany, to William Penn, dated August 21, 1682; an excellent reproduction of the Charter of Charles II to William Penn, dated August, 1682; and an old document signed by William Denny in 1756; certificate of the incorporation of the Pennsylvania Prison Society, founded in 1731, said to be the first in the world, of which Bishop White was the first president; also the certificate of the incorporation of a Society for the Abolition of Slavery, the first society of the kind organized in the world.

New Jersey, like Pennsylvania and Massachusetts, had a colonial building representing the Morristown headquarters of General Washington. The house has a broad, square hall, with circular gallery above, into which the chambers opened. There were no relics in this building, but in the New Jersey case in the rotunda of the Government building were a number of interesting objects. Among these was some pewter ware of 1600 and some Delft ware in use in 1758; a pair of glass saltcellars used by General Washington when entertaining Lafayette; some china and household articles from Salem County, N. J.; and an old communion service used in Friesburg, Salem County, N. J., as early as 1726.

As the States of Pennsylvania and New Jersey lie so near each other their relics, like their history, have become confused, hence in the New Jersey collection were to be found such objects connected with the history of Pennsylvania in the Revolution as the watch that lay on the table when the Declaration was being signed; and a large silver watch, once the property of Lydia Darrach, which, with the little story belonging to it, interested many Western visitors to the

PHILADELPHIA ROOM, PENNSYLVANIA STATE BUILDING.

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TEA CADDY; PAIR OF TOPAZ BRACELETS; OLD SPANISH COIN USED IN 1732.

POSSET CUP AND TRAY, WITH COAT OF ARMS; OLD ENGLISH PUNCH LADLE, WITH COIN IN BOTTOM, GEORGE II; ENGLISH SILVER TANKARD.

Mail

Fair, who read it for the first time the stirring tale of how Lydia Darrach informed Washington of the movements of the British while they were in possession of Philadelphia. Here also was the sword of Major Walton, first major of the First Regiment of New Jersey troops; an epaulette worn by General Washington and given by him to his secretary, Maj. William Jackson, of Philadelphia, from whom it passed into the possession of its present owner, Philip Physick Peace; a Masonic apron worn by General Washington. In connection with this a Masonic emblem once worn by Lafayette, and, as if to link together the States of Pennsylvania, New Jersey, and Massachusetts, an interesting relic of the early settlement of the latter State was a watch brought by Peregrine White for his son Benjamin in 1655, which passed, through Margaret White, to the May family of Pennsylvania.

Little Delaware, both in her State building and in the Government building, made a good representation among her larger sisters. Among other interesting objects were to be found pewter plates brought over in the *Welcome*, 1682; a Columbus coffee pot of English ware; a Britannia soup tureen, buried at the battle of the Brandywine; a watch, over 100 years old, carried at the same battle; an old family umbrella from the family of Bishop Coleman; and a hominy mortar, which has been in the possession of the Deputy family for 200 years, which from its worn and battered appearance has evidently done good service for the Deputys, in the days when hominy had to be prepared in the household instead of being bought at the corner grocery. Among the specimens of old china, of which there was a beautiful collection in the Delaware house, were some handsome pieces of old Dutch china and Staffordshire china of 1685, in different colors, especially mulberry and blue; a Jefferson plate of old blue English china; a quaint millenium plate; a very fine small plate that belonged to Robert Morris; some pieces of china of John McKinley, early governor of Delaware; and a William Penn plate from the Stevens family at Hoboken, N. J. In proximity to these more elegant articles of household use were a tallow dip and snuffers, a Dutch pipe used by Hessian soldiers, an iron spider from the home of Cæsar Rodney (signer), an old fire bucket, a warming pan from the family of Governor McKee, and a spoon-shaped bullet mold used in the family of Eleazer Clarke.

Here also was a Scotch communion service over 100 years old; an elaborate altar cloth worked by Queen Anne, marked A. R., presented by her to St. Anne's Church, Middletown, Del., and a Breeches Bible, printed in London in 1599. Among valuable manuscript documents were an original deed of land from Francis Lovelace, 1671; another from John Penn; a survey map of 1764; and an original deed from Lord Baltimore, signed Frederic Baron, of Baltimore, with seal attached. Nothing in this collection attracted more attention than a

housewife worn by Mary Harvey Brinton, at Chadds Ford, when she talked with General Washington on the morning of the battle of the Brandywine, September, 1777. Of later date was a banner presented by the ladies of Wilmington, carried at the ratification of the Federal Constitution, 1787; and a time-table of the first steam cars that left New Castle for Frenchtown, a stage coach on tracks, 1833.

In the Maryland Statehouse were no objects of historic interest; but in the Maryland case in the Government building was a rich display of silver, china, and jewels, many of which are still in the families of descendents of their original owners. Here were a silver pap bowl, posset cup, and tray which belonged to Edward Lloyd, first councilor-general of Maryland, 1709–1713; a handsome punch ladle, old English, with coin of George II in bottom, presented to Mr. Barbour in 1740; an English tankard, silver, which belonged to Nicholas Macubin, high sheriff of Anne Arundel County, Md., in 1733.

A pair of curious, large, heavy bracelets of gold and topaz which belonged to Mrs. Luke Barbour in 1750; a Spanish coin, current in the colonies in 1732; and a silver tea caddy which belonged to Thomas Gough in 1720.

In this rich Maryland case were also a set of amethysts of Miss Ann Owen; a ring that belonged to Betty Martin, grandmother of Governor William Paca, of Maryland; a fan dating back to 1710; a gold watch of James Lloyd, of Wye House; and numerous pieces of jewelry and silverware from the Goldsboroughs, Carrolls, and Johnsons, among these a silver mustard pot; tray and sugar tongs which belonged to Martha Washington, and near it a gold watch given by her to Mrs. Custis; a Washington candlestick; a large silver tray with Carroll coat of arms, presented to Nicholas Carroll, in 1798, by Mary Clare Carroll, lady abbess of a convent in Spain; and a silver jewel casket owned by Charles Carroll, barrister.

Near these articles, which spoke of wealth and luxury among certain leading families in Maryland, were a number of relics associated with her share in the colonial and revolutionary struggles, among these a sword, with heavy iron handle, found thirty years ago entangled in the roots of a large oak tree which had blown down on the field of Braddock's defeat (1755); swords of Gen. John Eager Howard and of Nicholas Carroll, and pistols taken from the Hessians at Trenton. Here also were a spoon mold of 1716; some interesting medals and miniatures, among these a miniature of John Spear by Major André; and, among manuscripts, an old deed of purchase, issued during the proprietorship of Charles Baron, of Baltimore; and later, but not less valuable, the original draft of the Star Spangled Banner, in the handwriting of Francis Keys.

Although Virginia exhibited no colonial relics in the rotunda of the Government building, those gathered together in the Virginia State building formed, in connection with the Washington letters, swords,

and other relics in the Department of State and in the French house, a most valuable collection of Washingtoniana. In the Virginia house, which was modeled after Mount Vernon, were numerous articles in daily use in that historic home. Here was the escretoire used by Washington, a snuffbox given him by Lafayette; his stirrup, pocket-knife, cup and saucer, and muffin dish; also the tea caddy, cup and saucer, and table bell used by Mrs. Washington at Mount Vernon; two brass candlesticks, and a brass door knocker which belonged to the Washington family. In this building were several Washington portraits, one of the three full-length Washington by C. W. Peale, the property of Mrs. Robert Carter, of Shirley, Va.; another of these full-length Peale portraits was in the Princeton College exhibit in the gallery of the liberal arts; while a small picture, evidently from the same sitting, was among the Lafayette relics in the French Government building. As this small portrait matched a Lafayette portrait in size, it was probably intended as a companion to it. In addition to these portraits were numerous paintings in oil and water colors, and pieces of embroidery in silk and chenille executed by Nellie Custis, the granddaughter of Mrs. Washington, these last from Audley, the home of her husband, Lawrence Lewis.

A violin was shown which was made by Albert Aylor, of Haywood, Madison County, Va., one hundred years ago; while near it were the harpsichord of Mrs. James Madison, the spinet of Nellie Custis, the telescope of Thomas Jefferson, and handsome silver, the property of Sir William Berkeley, governor of Virginia in the middle of the last century, and used by him at that time; also handsome chairs and other household articles from Mount Vernon, from Brandon, and from Audley. Not the least interesting among the articles exhibited in the Virginia home was a famous peace pipe smoked by John Smith and Powhatan. This latter came to Chicago with excellent credentials and a direct line of ancestry attached to it by its owners.

Although the relics exhibited by North Carolina were not as numerous as those of some of the other States, there were few among them that did not awaken much interest, either from their distinct value or from their close association with the history of the State and nation. Here was a fine copy of the first book published relating to North Carolina, Hariot's Brief and Fine Report of the New Found Land of Virginia, De Bey's Latin edition of 1590, with John White's[1] drawings of Indians and their costumes; also a caricature entitled "The Downfall of Oppression," illustrating the rebellion of 1775, London; a portrait of Flora McDonald, who saved the life of Prince Charlie before she emigrated to North Carolina; certificate of the first Episcopal ordination in the colonies, the Rev. William Hooper, signed by the bishop of Glocester (sic) 1747; a proclamation of Governor Tryon with seal of North Carolina attached, 1771; a characteristic letter of

[1]John White was the grandfather of Virginia Dare.

Dr. Franklin to his cousin, Kezia Coffin, written from London, 1765, still in possession of Kezia Coffin's descendants, also a portrait of Kezia Coffin; a marriage license of 1770; colonial currency and papers 1748–1771, while among articles illustrating the early life of the State was a street lamp used by the Moravian settlers in 1760, handsome silver service and ornaments from the homes of such early governors as Johnston and Eden and from the De Rosset family, including a tankard over 200 years old; also knee and shoe buckles once worn by these old governors; some handsome pieces of silver which belonged to Mrs. Thomas Barker were shown, and an amusing caricature of the same lady, Penelope Barker, presiding over the historic Edenton Tea Party, of which the following account is given by Richard Dillard:

This association, formed October, 1774, was presided over by Mrs. Penelope Barker, and joined by Mrs. Elizabeth King, Mrs. Sarah Valentine, Miss Isabella Johnston, a sister of Governor Johnston, of North Carolina, Mrs. Hoskins, and forty-six other women, who signed a paper which read as follows: "We the ladys of Edenton do hereby solemnly engage not to Conform to that Pernicious Custom of Drinking Tea, or that we the aforesaid Ladys will not promote ye wear of any manufacture from England, untill such time that all Acts which tend to enslave our Native Country shall be repealed."

The rich and full historic exhibit of the United States Government in the Department of State and its admirable arrangement are treated of at length elsewhere, but it is impossible to speak of the colonial and revolutionary relics at the World's Fair of 1893 without adverting to this most valuable and instructive collection. Here were to be found autograph letters and proclamations of all the Presidents of the United States from the time of Washington, Adams, and Jefferson to that of Lincoln, Grant, Garfield, Cleveland, and Harrison. In addition to these, the cases were full of important documents of State, from the Declaration of Independence[1] to the "Shark's Tooth," the original and unique treaty of the King of Samoa; also the Ashburton Treaty with the signatures of Victoria R., and many early treaties and documents illustrating the relations between France and America, while the walls upon both sides were lined with portraits and engravings of distinguished personages, native and foreign, the Presidents, Chief Justices, State officials, and sovereigns who took part in these treaties, and whose names were signed to letters and documents in the cases near by.

Especially interesting and valuable was a collection of flags in the Department of State which gave a connected idea of the evolution of the United States flag from the banners borne in the colonial wars and in the early days of the revolution; from the English flag with its red cross of St. George, which Endicott cut out of the blue field as a protest against popery, and the later colonial flag with its rattlesnake and "Don't tread on me" to the banner of 1777, with its red

[1] An impression taken from the original and bearing the ink of the original document.

stripes and blue field with white stars upon it, which, in the appropriate words of the resolution of the Congress of June 14, 1777, represented "a new constellation which had taken its place in the heavens."

Another and unexpected quarter in which were to be found many revolutionary relics was the French building. In a beautiful hall hung with tapestry, modeled after the Salle des Ambassadeurs at Versailles, where Franklin, Deane, and Arthur Lee were received, were gathered together numerous articles associated with Lafayette's life and military services in America. Here were a number of gifts from Washington to Lafayette. Among these a ring containing a strand of Washington's own chestnut hair interwoven with a silver lock of Mrs. Washington's; the insignia of the Society of the Cincinnati presented by Washington to Lafayette and worn by him; pistols used by Washington left to Lafayette in his will, and many other articles of personal as well as of historic interest. One of the most interesting objects in the French collection was a handsome sword, voted to Lafayette by the American Congress and conveyed to him at Havre by the grandson of Benjamin Franklin, in 1779. The handle of this sword is of solid gold, decorated with the arms and motto of Lafayette, "Curnon," scenes from engagements in which he participated, and other appropriate subjects, the whole so admirably executed that it may justly be considered a chef d'œuvre of art. In the substitution of another for the original blade the following history is given of this sword, of which only the original handle and ornaments remain:

During the Reign of Terror Madame Lafayette, who was then at Chavaniac, had the sword buried under the chateau to protect it from the revolutionary vandals. Lafayette was then, and for years afterwards, kept in secret solitary confinement at Magdeburg and Olmutz by the coalition, and it was only upon the return of his son, George Washington Lafayette, from America, that the weapon was disinterred. The blade had been destroyed by the rust, but George was able to secure the handle and mountings, and notwithstanding the danger of carrying gold out of France, to convey them to his father, who, released from captivity, had found an asylum in Holland. When Lafayette returned to his country after the eighteenth Brumaire, he conceived the happy thought of adjusting to this handle the blade of a sword presented to him in October, 1791, by the National Guard of Paris, when he made his adieux to that force, this latter blade having been forged from the bolts of the Bastile, which he had helped to destroy. Thus the handle and the blade given as acknowledgments of Lafayette's services to the cause of liberty upon both continents were finally united.

Upon the walls of this room were hung fine pieces of tapestry illustrating the battles in which Lafayette had served the cause of the colonies, and near these, carefully framed, were a number of manuscript letters to Lafayette from Thomas Jefferson, John Quincy Adams, and Washington. One of the latter, written at the time of the birth of Lafayette's son, who was named for Washington, plainly reveals the strong tie which existed between the great American general and the young French officer. An interesting object in this collection was a

sugar bowl of china, with the names of the thirteen States around the edge, which was once used at Mount Vernon; also a chair cushion embroidered by Mrs. Washington and sent to Lafayette in 1825, after her death. Chair cushions of the same design and worked by the same hands are still to be seen in the home of the great-granddaughter of Martha Washington, Mrs. Beverly Kennon, Georgetown, D. C.

Among objects associated with Lafayette's second visit to America were a large book containing three sets of cotillions danced at a grand ball in Baltimore, given in his honor, a fine sword, with Damascus blade, presented by Col. Alexander Morris on behalf of the Ninth Regiment of New York, and a pair of crystal vases, given him on the occasion of his visit to Pittsburg, in 1824. These vases now belong to the Baroness de Brigode, granddaughter of Lafayette, and with them is preserved a letter of Lafayette's expressing his pleasure in his visit to the glass works of Messrs. Bakewell & Page, by which firm the vases were presented to him.

Those who generously allowed their relics to make the long journey to Jackson Park will be amply repaid if they can realize the great interest they excited, especially in the minds of that portion of the population which has been too busy with the problem of daily living to turn back to learn what lies behind it. To such persons, and thousands of them were to be found at the fair, especially upon the days celebrated by certain Western States, the historic exhibits were a great revelation, a never-failing source of interest, and a most important object lesson in the history of a nation that has gained so much of its present importance and prosperity through the exertions and self-sacrifice of individuals.

LARGE SILVER TRAY, WITH CARROLL COAT OF ARMS; SILVER JEWEL BOX; SILVER TEA CADDY, 1720.

SWORD FOUND ENTANGLED IN THE ROOTS OF A TREE THIRTY YEARS AGO, WHICH HAD BLOWN DOWN ON THE FIELD OF BRADDOCK'S DEFEAT, BATTLE OF FORT DUQUESNE, JULY 9, 1755.

DO NOT

CARICATURE OF "EDENTON TEA PARTY, 1774," FROM A PAINTING PRESENTED VIRGINIA DARE MEMORIAL ASSOCIATION BY RICHARD DILLARD.

DO NOT

PORTRAITS OF COLUMBUS.

BY

Prof. THOMAS WILSON, Judge.

PORTRAITS OF COLUMBUS.

By Prof. THOMAS WILSON.

It is not possible to give intelligent awards upon the various portraits of Columbus which have been gathered by Mr. William E. Curtis for the World's Columbian Exposition and exhibited in the Convent of La Rabida as a part of the exhibit of the Department of State at Washington without a preliminary statement.

There have been presented to the public no less than seventy-one pictures—oil paintings, engravings, sketches, and drawings—each one of them having at some time or other been presented to the public as a portrait of the great discoverer. All degrees of positiveness have been employed by their owners and advocates in declaring for the genuineness and authenticity of these portraits and in asserting that they were more or less taken from life or copied from pictures which were. It is due to Mr. Curtis to say that he has at no time asserted the genuineness of any of the portraits composing his collection, but has presented them as an interesting study in order that those desiring to investigate the subject may compare the different ideas of the appearance of Columbus, as presented by the different artists, side by side with an intelligent recital of their history and assurances in the catalogue of the exhibit which he prepared.

The question, "Have we a portrait of Columbus?" has been under discussion for more than a century, and has been investigated by some famous historians, artists, and archæologists of Europe. Committees have been appointed by historical and scientific organizations to make thorough investigations, and their reports have been published in the leading journals. The literature bearing upon this subject is voluminous and in several languages, and, leaving aside the arguments that have been written to sustain the claims of particular portraits, it may be said that the consensus of opinion among artists and historians is that there is no evidence that any portrait of Columbus was painted or engraved during his life.

Let us consider in a few words the requirements of an affirmative conclusion. It must be known with reasonable certainty that Columbus while at a given city, during one of his visits known to history, sat for his portrait to a certain painter. This portrait must either be

traced from hand to hand to the present time and identified as a particular one now in existence, or else it must have had such marks upon it that it could be identified. It must be conceded that this evidence has never been produced. It is not known from any historian or biographer of Columbus that he ever sat for his portrait at any time or at any place, and of the portraits painted and which have been claimed to be of him, there is no evidence of continuous transmission, nor of particular description by marks or otherwise, which will enable anyone now to make a positive or satisfactory identification. Evidence of the authenticity of a portrait of Columbus such as exists with regard to portraits of the Kings of Spain, France, or England, or the Popes of Rome, contemporary with Columbus, fails altogether, and because of the distance of time and the difficulty of obtaining further minute details of Columbus's life it is highly improbable that it will ever be found. In announcing this conclusion, one is to take into consideration the increased interest on this subject manifested in this fourth century of the discovery of America, the widespread and profound researches made by scholars and students, the later investigations among the ancient records, whether of court or of state, among the official documents of every government, whether lay or ecclesiastic, all of which have apparently proved infructious.

Though forced to admit that we have no evidence of any portrait of Columbus painted from life, we are not, therefore, to conclude that the world is entirely without knowledge of his form and features derived from portraits.

There is in the United States Government building at this Exposition various series of portraits of the secretaries of the different Executive Departments of the Government. These series of portraits have been formed in the respective Departments at Washington and it has been the desire of the Government to make it as complete and truthful as possible. Anyone looking at these portraits would conclude them to be genuine and authentic portraits of the secretary represented, made during his lifetime, from sittings given by him, and the work of known artists belonging to the period indicated. But this is far from being correct. These series of portraits have only been commenced since the close of the war of the rebellion and are now but little more than twenty-five years old. I do not speak with exact knowledge, but it is within the truth that one-half these pictures were not painted from life, many of them were painted by artists who had never seen the secretary and to whom he certainly never sat. Yet these pictures stand as fair portraits of the secretaries they represent. To such extent has this method prevailed that a large proportion of the portraits of the heads of the bureaus and of the earlier secretaries now appearing on the walls as photographs and produced by photographic process have not been taken during the lifetime of the person represented. They are reproductions of early, or enlarge-

ments of possibly small, photographs, or were taken from sketches, drawings, or engravings; yet they are accepted as genuine portraits. If not reproduced during the lifetime of the individual it has been done during the lifetime of his friends and acquaintances, who were able to criticise and, if need be, correct the portraits in order to obtain a representation as lifelike as possible. When the artist employed was a reasonably good one, this is believed to have been accomplished.

This being true with regard to the official portraits of the great men of the United States of the past hundred years, how much more may we be satisfied with those portraits of Columbus that have the air of genuineness, the appearance of correct likeness, and which may have been authentic. Most of them are excellent specimens of artistic work. Several of them show the hand of a master. When we take into consideration the difference of time, locality, and nationality of the artist, the school to which he belonged, the costume of the different countries, we can look at the principal portraits of Columbus as they are shown in the World's Columbian Exposition (to which, however, should be added some others in order to complete the series), and we can have about as good an understanding of the features and appearance of Columbus as we have of half of the generals in the Revolutionary army, or of Washington's first Cabinet.

The portraits displayed in this Exposition are on undoubted antiquity, have been guarded with great care, and have received the best attention and treatment at the hands of their owners. That they believe them to be authentic portraits of Columbus may readily be conceived, and that they prize them accordingly is not to be doubted. These portraits are regarded by their owners as treasures. Some of them have been in their present families during many generations, while those which have been purchased lately have only been secured by the expenditure of large sums of money. Each one of these represents to its owner a fortune. Without arrogating the position of art critic above the world or assuming to determine that either one of these has the advantage over another in having greater evidence of genuineness and authenticity as a portrait of Columbus, it is to be acknowledged that the owners of these portraits have displayed a generosity toward our people and have shown the greatest confidence in the integrity, good faith, and careful painstaking of Mr. Curtis and of this Exposition to expose such perishable treasures to the hazards and accidents of transportation, by sea and land, in order to display them (these portraits) to the admiring gaze of 20,000,000 of our countrymen. As a conclusion from this argument, it is the duty of the judges to recommend awards in favor of the five oil portraits displayed.

The Yañez portraits, loaned by the Government of Spain from the National Library at Madrid; the Lotto-Ellsworth portrait, exhibited by Mr. James W. Ellsworth, of Chicago; the portrait loaned by the

Duke of Talleyrand; the portrait loaned by William Harrison Bradley, of Chicago, late United States Consul at Nice; the portrait painted by Sir Anthony Moro, exhibited by Charles F. Gunther, of Chicago.

I recommend them for an award for, first, their historical value; second, their excellence as works of art of mediæval antiquity; third, their advancement of our knowledge concerning the appearance of Columbus, and fourth, as a recognition of the consideration and generosity of their owners in exposing their valuable treasures to the risk and damage incident to an international exposition for the sole purpose of increasing its attractions and benefiting the people.

COLLECTIVE EXHIBIT IN THE CONVENT OF LA RABIDA, AT THE WORLD'S COLUMBIAN EXPOSITION.

BY

THOMAS WILSON, Judge.

COLLECTIVE EXHIBIT IN THE CONVENT OF LA RABIDA, AT THE WORLD'S COLUMBIAN EXPOSITION.

By THOMAS WILSON, *Judge.*

What the heart is to the body, the fountain of life, the center of circulation, the Convent of La Rabida is to the World's Columbian Exposition. It is the source, the origin, the cause. This Exposition extensive, costly, magnificent as it is, began in the Convent of La Rabida. As the little rootlet, which deep in the ground gathers its sap and sends it through all the ramifications of root, trunk, branch, and leaf, and culminates in the flower, so La Rabida is the root of discovery in the Western World, while this Exposition is the flower of its civilization, blooming at the end of four hundred years. But for the shelter given by La Rabida to Columbus, but for the plans which he concocted under its roof, but for the aid, comfort, and sympathy he received from its brethren, the priests, this Columbian Exposition would never have existed. Whatever may be due to the spirit, patriotism, energy, and great wealth of the citizens of Chicago and of the United States, and whatever aid they may have received from foreign Governments or foreign peoples, this Columbian Exposition would never have had an existence but for the part in the great drama of civilization which was played by the Convent La Rabida. Other men might have discovered America if Columbus and La Rabida had never had existence. The spirit of adventure in modern times will be cited to show that the discovery of America would have been made by others if it had not then been made by Columbus. But who can say which one of these is cause and which effect. May it not be true that the spirit of adventure and the thirst for discovery grew out of Columbus's acts rather that the reverse? However this may be, true it is, as true it must be, that if some other man had discovered America at some other and later time we would not be celebrating the 400th anniversary of the Columbian discovery.

It was at La Rabida that Columbus applied for shelter when he arrived in Spain from Portugal. It was there he lived while fitting out his ships for the first voyage. It was from La Rabida that he received the blessings of the Church when he sailed, and it was by the friendly monks in the little chapel of La Rabida the Te Deum of joy was sung upon the return of Columbus from his newly discovered world. It was a happy thought on the part of its originators and a

grand idea on the part of its executors—the Latin-American Department—and it is in accordance with the eternal fitness of things to place upon these Exposition grounds this simple little structure which unwittingly began the movement that produced this Exposition. It is fitting that here should be shown the contrasts between the two epochs of American civilization. On one side the seed, the rootlet, and on the other the full-blown flower. On one side the plain building without ornament or decoration, while on the others are shown the magnificent architectural triumphs of the nineteenth century. Thus, according to the idea of the originators, is shown the Alpha and Omega of American civilization.

The Convent of La Rabida stands on a low promontory or headland facing the sea at the junction of the Tinto and Odiel rivers. It is about 2 miles from the town of Palos, which was the ancient port, and that from which Columbus sailed, and is about 8 miles from Huelva, the modern port. The word La Rabida in English means "frontier," and the full name of the convent was Santa Maria de La Rabida. So the convent stands on that which had been known from the beginnings of our knowledge of history as the frontiers between land and sea. In the contest which goes on continually between land and sea, wherever it may be found, the sea, with its almost irresistible force and power, usually gains upon the land and eats its way in, but at La Rabida the silent forces of the land have gained upon the sea, and what was in Columbus's time the enterprising port of Palos has now been filled up and is covered with sedge grass. It is with trouble that the small local trading boats can pass in any direction. The trade and commerce by sea has all turned to Huelva, and the port of Palos, out of which sailed the fleets of Columbus to discover America, which carried the army of Cortes to the conquest of Mexico and Pizzaro to South America, is now closed.

The building of the Convent of La Rabida and the giving of its name Santa Maria occurred in this wise: While the Roman Emperor Trajan was at Seville his lovely daughter Prosperine died. The governor of the province erected a temple in her memory on the site where La Rabida stands and placed upon the altar a golden image of the beautiful girl and awarded it a fête day. In the next century this temple passed into the hands of the Christians, who assimilated the festival of Prosperine with their own ceremonies and called it the Candelaria or the purification in memory of the double mystery of the Holy Virgin and the presentation of the child Jesus. At that time there was brought by a devout seaman, Constantino Daniel, a resident of Jerusalem, an image in alabaster representing the Holy Virgin Mary and which was said to have been carved by the Apostle St. Luke. In the year 331 this image of the Virgin was established upon the altar of La Rabida in place of the golden image of Prosperine and the name of the convent was given Santa Maria de La Rabida.

The convent remained in this condition, a place of great veneration and high repute among the peoples of Spain, who flocked to it in great numbers upon the proper fête days. In the early part of the eighth century the Moors invaded Spain and took possession of La Rabida. To prevent the desecration of the holy image, those in charge of it took it from its place and sunk it in the ocean. The Moors, in the endeavor to sustain its high repute as a holy place, installed upon the altar a sacred bone from the Prophet Mahomet, which had the effect to make La Rabida as highly venerated by Mohommedans as it had before been by Christians. The Moors retained possession of Spain until the time of Ferdinand and Isabella, and we all know by history how the preoccupation of the minds of these monarchs with their expulsion interfered with the consideration of the plans of Columbus and was the cause of that procrastination and neglect which produced so much of his despondency and unhappiness at that time.

About 1472, a few years before Columbus arrived at La Rabida, the Moors had been driven out of that portion of Spain and had concentrated their forces and their power at Granada; the convent passed into the hands of the monks of the Order of St. Francis, and it was during their occupation that Columbus had all his relations with the convent.

Shortly after the restoration of the convent to these monks a fisherman of Palos, in drawing his net, found in its meshes the alabaster image which had been brought from Jerusalem and which more than seven hundred years before had been cast into the water rather than be subjected to the desecration of the Moors. It was thereupon restored to its ancient place upon the altar and the convent given its ancient name of Santa Maria de La Rabida.

Columbus made his first visit to La Rabida by accident when leaving Portugal on his way to Moquer, a small village of the neighborhood, for the purpose of placing his little son Diego, then 9 years old, with his sister-in-law, a woman named Muliar, while he went to present himself at the Court of Ferdinand and Isabella at Cordova for the purpose of asking their aid in his proposed discoveries. The good monks detained him several months for rest and refreshment and upon his departure gave him letters to influential friends at Court. His second visit was upon his return from his unsuccessful visit to the Court, and when, wearied and disheartened by difficulties and delay he was preparing to leave Spain, as before he had left Portugal, to present his plans to the more friendly powers of France or Genoa or Venice. The good monks of La Rabida again rested and refreshed him and gave him so much of their comfort and sympathy as that he was persuaded to return to Court for the further presentation of his plans.

His third visit was in May of 1492, when he came bearing the original contract, here shown in La Rabida, made by him with Ferdinand

and Isabella and dated Granada, April 30, 1492, appointing him grand admiral of the ocean seas, vice-king and governor-general of all the lands that he should discover. He made La Rábida his home until his departure on his voyage, bearing with him the fervent prayers of the pious monks.

His return, bringing with him the news of his successful voyage, the rapture with which he was received, the te deums of joy that were sung, and the general glorification over the newly discovered world are too well known to need repetition.

The Convent of La Rabida has remained in the possession of the Franciscan monks ever since. They had, as might have been expected, made alterations and additions to the structure. It was determined by the Government of Spain to make a proper celebration in commemoration of the discovery of America and that it should take place at the Convent of La Rabida on the four hundredth anniversary of that event. It was decreed that the convent should be restored to the same condition as in the time of Columbus. This was accordingly done, and on the 12th of October, 1892, the Queen of Spain, on behalf of her Government, gave to the Franciscan fathers a deed conveying to them in fee simple the premises with all their improvements. This event and the occasion was there celebrated by the Spanish Government, accompanied by all its members and grandees, and assisted by the war ships and representatives of 22 foreign nations. There was, at the same time, the inauguration of a noble monument of granite 150 feet high surmounted by a globe and an iron cross.

In 1890 Mr. William Elroy Curtis, of Washington, then an officer of the International American Conference and afterwards Chief of the Latin-American Bureau and a representative of the Department of State at the Columbian Exposition, suggested the idea of reproducing upon the Exposition grounds the Convent of La Rabida, in which should be united all obtainable relics of Columbus and those relating to the discovery of America. These suggestions were forwarded to Congress by the Hon. James G. Blaine, then Secretary of State, with his hearty indorsement, and Mr. Curtis's plan was incorporated in the report of the Committee of the House of Representatives on the World's Columbian Exposition.

But Congress having failed to make an appropriation to carry the plans into effect, Mr. Curtis appealed to the board of directors of the local corporation in Chicago, who promptly furnished him the money for the purpose. The collection of portraits and other pictures was made by Mr. Curtis, acting as the representative of the Department of State upon the board of management for the Government exhibit at the Exposition, and the expense was paid from the appropriation made by Congress for the use of that board.

The plans of Mr. Curtis also contemplated a search for relics of Columbus throughout the world and particularly those places in the

United States which were visited by him or identified with his career. The expense of carrying on this search was paid by the board of directors of the World's Columbian Exposition, and the work was done under the direction of Mr. Curtis by Mr. Frederick A. Ober, of Boston, and the officers of the United States man-of-war *Enterprise*. They visited nearly every place in America which is in any way identified with the history of Columbus, taking photographs and obtaining many interesting and valuable relics. Under the direction of Mr. Ober excavations were made among the ruins of the first three cities established on the American continent, the cities founded by Columbus in Santo Domingo, and the result was that a large number of interesting articles were discovered which belonged to the contemporaries of Columbus residing in those cities.

Mr. Curtis secured the passage of an act of Congress authorizing the President of the United States to request the loans of important historical documents from the Governments of England, France, Spain, Italy, His Holiness the Pope, the Duke of Veragua, the living representative of the Columbus family, the Duke of Alba, and other collectors. Under this law Mr. Curtis was designated to visit Europe and present the applications in the name of the President of the United States. This he did in the autumn of 1892, and the success of his visit is shown by the collection of historical papers in La Rabida.

Another of Mr. Curtis's schemes was the reproduction of the fleet of Columbus, and at his instance a bill was introduced in Congress authorizing their construction under the direction of the United States Navy. Lieut. W. McCarthy Little, U. S. N., was designated to superintend their building, which was done at Barcelona, Spain. They were completed in time and came around to take part in the celebration of the Fourth Centenary at Huelva, October 12, 1892. Mr. Curtis, with his aid, Lieutenant Little, attended this celebration and secured the services of Señor Velasquez, an architect and archæologist of Spain, in preparing the necessary plans and drawings of La Rabida in its original condition, so as to reproduce it with exactitude on the grounds of the Exposition. Señor Velasquez has been charged by his Government with the restoration of La Rabida to its original condition at the time of Columbus, and had general charge of the improvements relating to the celebration. These plans and sketches were intrusted to Mr. Henry D. Ives, one of the architects engaged upon the construction of the Exposition buildings. Mr. Ives entered into the work with ardor, and a reproduction of the Convent La Rabida has been constructed on a headland overlooking Lake Michigan, as the original might have overlooked the Atlantic Ocean, wherein is installed the relics of Columbus loaned by Spain, the Vatican, Queen Victoria, and many organizations, societies, and individuals of the highest rank. The objects gathered are of inestimable value and form the most complete collection relating to these

subjects ever made. Catalogues of the objects were prepared with considerable elaboration and placed at the disposal of the public during the continuance of the Exposition, and it is only a fair recognition and testimonial of the wisdom of the original idea and of the success with which it has been carried out, to say that this advancement of public knowledge and public interest in affairs relating to the history of our country, the result of the first public exhibition of these relics to 20,000,000 of our people in the Convent of La Rabida, is not to be calculated. The information furnished in the form of descriptive catalogues greatly aided the advancement of public knowledge.

The good judgment of Mr. William E. Curtis in bringing these objects together, and the energy and public spirit with which he carried it out, is a distinguishing mark of merit.

CORSETS AND DRESS-CUTTING SYSTEMS, ETC.

BY

HANNAH FREUD, Judge.

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CORSETS AND DRESS-CUTTING SYSTEMS, ETC.

By HANNAH FREUD, *Judge.*

The exhibit which should have been the most interesting in hygienic and in a beautiful sense is the corset and corset waist, as much depends on its construction for health comfort, and beauty. Much progress and many improvements have been made in these articles in the past few years; now every woman if she so desires can have a good form and be comfortable.

There were fine exhibits of these articles by France, Belgium, Brazil, Mexico, and the United States. The exhibits of the United States manufacturers were equal to the best of the foreign makes.

The industry of corset manufacturing is quite new in the United States, but has had a wonderful impetus in the past few years, which no doubt has been fostered by a judicious system of protection, and improved machinery, which has greatly lessened the cost of the production. I examined a very presentable and durable corset, manufactured by the Coronet Corset Company, which Mr. Weeks, its president, assured me took only fifty-three minutes to make and box ready for shipment. There is no doubt it will not be many years before the United States will not only lead in the quantity, but also in quality and beauty of shapes. No nation can furnish more symmetrical and beautiful human models than can be had in the United States.

France was represented by H. P. F. Laprince, of Paris, and Farcy & Oppenheim, of Paris, who are the manufacturers of the C. P. a la Sirene corsets. Their exhibit was very beautiful; it combined French taste with French solidity. This house has received prizes in almost all the principal expositions, so at the last one in Paris the head of firm was decorated with the Legion of Honor and was one of the judges. Their exhibit was consequently "Hors Concours." The sale of their goods is confined to Ottenheimer Brothers, of New York.

Belgium corset exhibit was represented by Dutoict & Co., of Brussels. It was very beautiful and complete and was one of the most attractive exhibits in that section. Joseph Beckel & Co. are the agents for the United States.

Austria's only exhibitor of corsets was V. Suppencia, of Vienna.

Brazil was represented by Madam Cornelle Dupeyrot, of Rio de Janeiro.

These corsets were especially adapted for long-waist forms.

Munfiel Foudou, of Mexico, was the only exhibitor in that section.

The Coronet Corset Company, of Jackson, Mich., had two new and interesting exhibits. One was their new flexibone molded corset. The term "Flexibone" is significant of the qualities of boning material used in the corset, and bearing the same relation to the old form of steel and hickory combination of stays that the nicely adjusted whalebone bears to them, but possessing features by virtue of its elasticity and unbreakable qualities, rendered so by chemical treatment, which, although its fundamental basis is of fine polished steel, is rendered perfectly rustless and wholly unaffected by either water or perspiration. By this process the full tension and elasticity of the steel is retained without prejudice, such as is the case by the process of enameling, galvanizing, or plating.

Another exhibit was the Jackson favorite waist. The development of the waist industry began about ten years ago. A patent was granted for the Jackson waist November 22, 1887, for an improved method of cording in place of bones or stays. The method adopted was the forming of a stay by banking the cords between a stiff material of heavily sized interlining, which enabled them to bone the cord between the lining and the outside of the garment, and re-cording the entire stay through the four-ply section thus formed, embedding them firmly.

The Grunet eyelet is especially desirable, as it impinges strongly upon the textile, not requiring a stay behind it.

The exhibit by Mayer Strouse, of New Haven, Conn., of their C. B. a la Sprite corsets was most beautiful in its great variety of shapes and materials used, and was worthy of the attention that was shown by all who were interested in the many improvements and advancement of the corset industry.

The C/B trade-mark derived its origin in 1886. The growth of their manufacture has so forced them that in order to obtain the proper results their corsets must pass through thirteen departments before they reach the boxing department. First, the material is stretched upon a cutting table 100 feet long, the material laying in thicknesses of 24 plies. The patterns, which are made of brass in the respective sizes, are nailed on the table, and the cutter then cuts around the brass patterns; second, to the steaming department; third, to the linen-binding department; fourth, gore-stitching department; fifth, striping department; sixth, clasp-stitching department; seventh, back-stitching department; eighth, binding department; ninth, eyeleting department; tenth, ironing department; eleventh, molding department; twelfth, embroidering and top-trimming department; thirteenth, examination and boxing department.

Much of the machinery and devices used in the art of manufacturing have been designed by their own mechanics, which has greatly improved and reduced the cost of manufacturing corsets. They now employ 1,600 people in their factory and salesroom.

The exhibit of the Royal Worcester Corset Company, of Worcester, Mass., was one of the most attractive exhibits. Each corset was on a life-size beautiful wax model, and the corsets were attractively made. This is one of the pioneer corset factories in the United States. Its president, D. F. Fanning, was the founder, who established it in 1861, with one sewing machine. They were incorporated in 1888 and now employ over 700 intelligent operators. Their products are sold in all the leading cities of the United States.

Wiengarten Brothers, of Newark, N. J., have only for a few years manufactured corsets, and have been very successful as manufacturers of extra long-waist corsets; and have a patent arrangement for transverse seams in their corset, which adds much to its durability.

Gage, Downs & Co., of Chicago, Ill., exhibited a large case of corsets and waists.

Van Orden Corset Company, of New York, exhibited corsets for women and children.

Mrs. Olivia C. Flint, of Boston, Mass., exhibited several waists, for women and children, on the hygienic principle.

Madam Newman, of Chicago, Ill., exhibited a very excellent shoulder brace, which is especially recommended for its simplicity and its effectiveness for pressing the shoulder blades in without much discomfort to the wearer.

Madam James, of Pomo, Cal., exhibited a skeleton shoulder brace. It had haircloth bust forms attached, which makes it especially adapted for very slender, undeveloped forms.

Delsarte Manufacturing Company, of New York and Chicago, exhibited a magnificent case of waists and bust supporters. The children's waists were quite different from anything exhibited. The front and back were made with elastic cross straps, so that they will give with every movement. Their bust supporters were practical; they laced on the side and back; the whalebone is put in diagonally under the bust to support it firmly.

Buck & Co., of Mattoon, Ill. Two of their exhibits were very interesting. Their child's waist showed much novelty in its construction; the arrangement of the shoulder straps was very effective; they crossed each other in the back and fastened in front; one button is used to fasten the back at the waist line. It fits the form well and gives the body and shoulders free action without strain or pull. Their Keystone brace and hose supporter has many points of excellence to recommend it. It can not strain the shoulders; the weight is so distributed over the back that all the weight suspended tends to hold the form perpendicularly. The Keystone clasp is a wedge-shaped slide of two pieces of metal.

The Lindsey improved self-locking button and lock clasp, exhibited by J. C. Haley & Co., of New York, is one of the most popular clasps for hose supporters in use. To Mrs. J. C. Haley is due the credit of

having suggested and caused this clasp to be developed and patented. The latest improvement is the self-locking and loop clasp which was patented June, 1893.

For the past ten or twelve years the price of Arctic whalebone has steadily advanced, so that it has been quite an incentive to inventors to invent substitutes. Steel, horn, quill, feathers, leather, paper, coraline, jute cord, and many other devices have been put into use, but as yet there is no invention used that is as satisfactory as Arctic whalebone for boning dresses or corsets.

The New England Whalebone Company, of New York, had a very choice and artistically arranged display, which was greatly admired.

The dress-cutting systems, like all other inventions, have passed through many changes. Drafting machines and systems that were thought perfect ten years ago, when tested next to the methods of to-day, make us wonder at their crudeness and many imperfections. Many advancements have been made in the past few years. To-day, with its many improvements, almost anyone can draft and cut a perfect-fitting garment after a few instructions. The many devices and methods used are almost bewildering; many have some special merit to recommend them.

The McDowell garment-drafting machines have much to recommend them, as they are simple and are easily learned. They drafted, cut, and put together a waist and sleeves in my presence in less than one hour. The waist fitted without a wrinkle. The young lady, no doubt, was a very adept worker. The drafting machine is made of brass and can be arranged so that any style or shape of garment can be drafted. It was patented in 1879, 1885, and 1886. They also have a drafting machine for men's tailoring. These are useful inventions, which are great time savers. The claims made for the McDowell garment-drafting machine are that it is the simplest way of using actual measure and is as reliable as the measures themselves.

The dressmaking art is keeping pace in improvements with all other industries. It has right at hand corsets of every kind to improve the form and strengthen the body, and has systems of cutting equal to the best used by man.

The scientific garment-cutting system of the French-Prussian mode was patented 1882, 1885, and 1887. It is a tailor square and graduating measuring scale, invented by H. Avers Jackson, of Chicago, Ill.

Mrs. H. A. Brown, of Boston, Mass., has a system that is a simple leather chart, which was patented November, 1888.

Mrs. Elmere Cromwell, of Chicago, Ill., was the originator of the Cromwell system of cutting when only 16 years old; was patented in 1870. Its special merit is that a child can easily learn to draft and cut. I saw a child of less than 10 years cut and fit nicely by it. It is used in many industrial schools and colleges.

Mrs. M. S. Schafors, of Chicago, Ill., is the inventor of the metal and tailor square dress and undergarment cutting system.

An attractive exhibit was made by the Brooklyn Shield Company of rubber shields. The specific points of excellence are that their shields are light weight, soft, impervious, odorless, and finely finished.

The dress-shield industry is quite an old industry, the first shields having been made over one hundred years ago, but it is only in the last ten years that great improvements have been made.

Jean Ulrich, of Chicago, Ill., exhibited a unique combination riding habit, walking dress, and ulster, for which he has obtained a patent. It is a useful and economical garment, which can be readily changed from a plain tailor-made costume to a perfect-fitting riding habit; by adjusting a button and the addition of a stylish cape this garment is changed to a convenient traveling costume.

The exhibit of gowns and wraps in the French department was beautifully and magnificently represented by Madam Sarah Meyer & Sons, of Paris; also by Arnold Recahenbach & Co., Rauff, L. Storch, and Albert Weil, of Paris. All their exhibits of gowns and wraps were marvels of beauty and elegance. To the French belong the talent of blending colors and harmonizing trimmings.

The exhibit of riding habits, ladies' gowns, misses' and children's frocks, and boys' clothing by L. P. Hollander, of New York, Boston, and Newport, showed superior workmanship and exquisite style. The firm was founded in 1848 by M. G. Hollander; twenty-five years ago it passed into the hands of the sons. From small beginnings it has increased to such proportions that now from 400 to 500 people are employed in the various departments. In 1853, at the old Crystal Palace in New York, they were represented by an elaborate display of fine needlework, which attracted considerable attention and was well illustrated in the pictorials of the day.

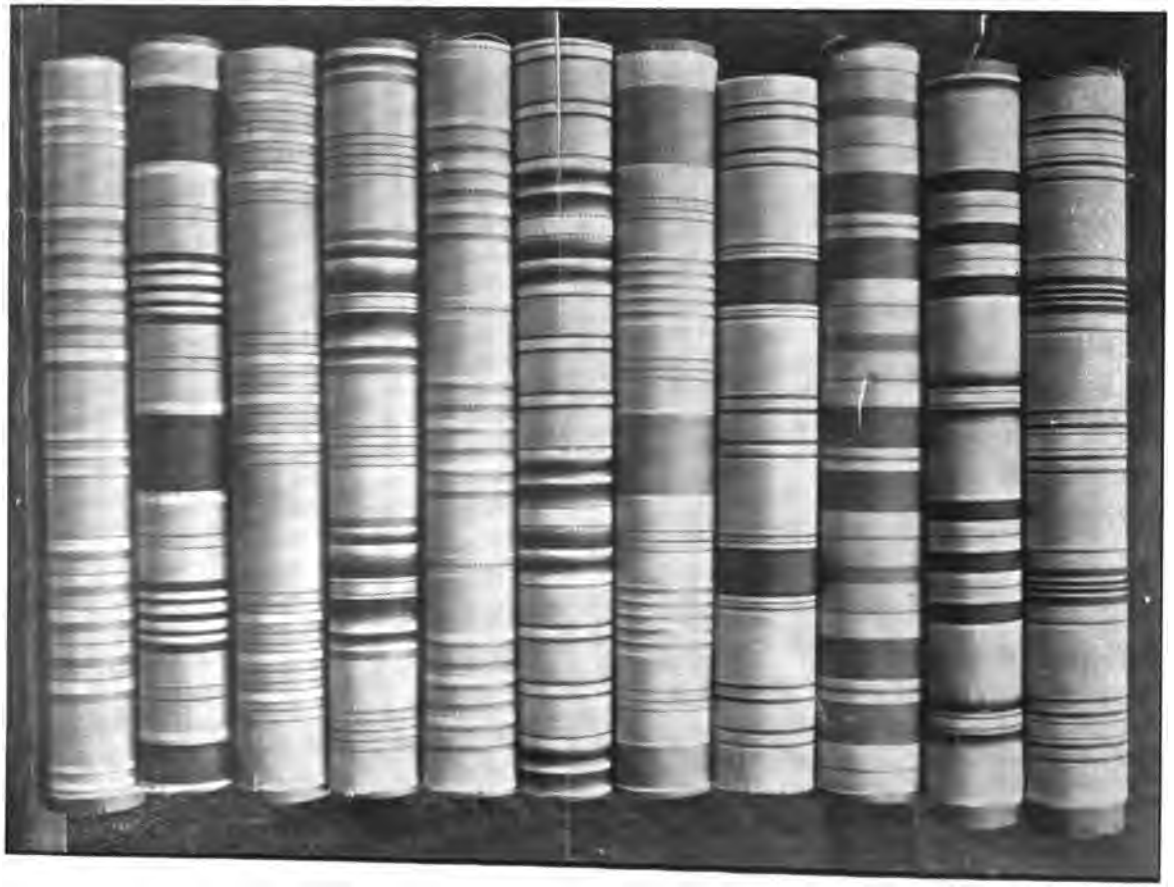
Strawbridge & Clothier, of Philadelphia, Pa., had a very attractive display of costumes and wraps.

COTTON THREADS AND FABRICS.

BY

Mrs. PETER M. WILSON.

COTTON PICKING NEAR ANNISTON.



THE FINISHED PRODUCT.

COTTON THREADS AND FABRICS.

By Mrs. PETER M. WILSON.

In a review of textiles as shown at the World's Columbian Exposition, cotton, it must be conceded, takes precedence both in variety and in extent of its exhibits and in the progress made in the art of manufacturing its threads and fabrics.

The displays made by the exhibitors of the United States were very creditable and fully sustained these claims. The world's yield of this staple has become so immense that the steady increase of means and methods of manufacturing it has followed as a natural effect. The number of bales of cotton produced in 1875 in the world was about 9,500,000; in the United States, 3,827,845. The number of bales of cotton produced in 1892 in the world was 14,500,000; in the United States, 9,035,379.

In the past few years a marked disposition may be noted to establish the factories near the cotton fields. The prime motive in this step is economy in transportation and labor, and it may be presumed that eventually the cotton-growing States will become the seat of the manufacture of the coarser grades of this enormous industry.

In a summary of this kind it would not seem advisable to mention all who received diplomas at the World's Columbian Exposition, because under the system of awards adopted by the authorities these diplomas were general in description, and the specific points of excellence of each exhibit rest in the comparison of words used by the judges in their certificates of merit. The true ends aimed at, it is believed, can be attained by citing the following instances of extraordinary merit:

The noted Lonsdale Company, of Providence, R. I., had fine exhibits of sheetings, shirtings, twills, sateens, and hollands, all superior in manufacture; the Berkeley Company, of Providence, with their beautifully fine mulls, lawns, and cambrics; the heavy domestics of the New York Mills, and Dwight Mills, of Chicopee, Mass., and B. & B. Knight, of Providence, R. I. This last-named company started in 1835, with 4,000 spindles, and now, in 1893, they have 420,000.

The Lenox Mills (Kneedler & Co.), Philadelphia, started in 1883 with 60 looms, and now run 188. These mills make a specialty of bed-

tickings which show marked progress in the quality of weaving and finish, the sateen striped ticking having no competition in the United States, and both in designing and finish are of marked superiority.

The Aberfoyle Manufacturing Company, of Chester, Pa., deserved especial mention for their striped ginghams, japonettes, cotton crepes, etc. These goods were superior in quality and fineness of count, and remarkable for brightness and delicacy of coloring.

The threads displayed by the Glasgow Lace Company, of Glasgow, Conn., showed a new and acceptable departure. These goods were given a twill finish. The effect produced when worked into lace is wonderfully pretty.

The threads of the Hadley Company, of Holyoke, Mass., were very uniform in strength and finish.

A class of cotton goods adapted to the needs of our greatest number were the homespuns of the Mississippi Mills, of Wesson, Miss. These goods are durable in texture and color and reasonable in price.

The Knitted Mattress Company, of Canton Junction, Mass., exhibited a cotton fabric knitted together by machinery, very valuable for upholstery and carpet lining.

In simplicity and elegance in designing the exhibits made by the English and Spanish mills were superior to all others. The introduction of the cotton manufacture into England took place in the latter part of the sixteenth century, when French and Flemish Protestants sought protection in these isles from the religious persecution then raging in their own countries. The principal exhibitors of cotton goods from Great Britain were Barlow & Jones, Limited, of Bolton and Manchester; Messrs. Ferguson & Bros., Carlisle; Swainson, Birley & Co., of Preston; and John Brown & Son, Glasgow, Scotland.

Who that visited the great Columbian Exposition can forget, in Barlow & Jones, the splendid Turkish towelings, the wonderful marseilles quilts in brown and blue and white, with their delicate designs so clearly and distinctly brought out, and then the Statute of Liberty woven in white on a brown background, and the Albert Memorial in similar colors, works of art showing to what perfection cotton manufacture can be brought. Then the splendid sheetings of Swainson, Birley & Co., followed by Ferguson & Bro.'s silesias in lovely shades and beautiful finish; and John Brown & Son's madras curtains, pronounced to be beyond compare for simplicity and elegance in designs; and the velveteens for draperies of Stockdale & Turnbull, which stood unharmed without glass protection for six months, shown, too, in rich yellows, greens, and blues, in designs that were at once classic, harmonious, simple, and elegant.

Spain procures her raw cotton from North America and the Philippine Islands. The principal places in North America from which she imports cotton are New Orleans, Mobile, and Savannah. Barcelona,

Valencia, and Malaga are the manufacturing towns, of which Barcelona is the most important. The goods manufactured are calico, cashmere, brilliantines, velvets, cotton flannels, dress goods, goods of cotton mixed with silk and mixed with wool, and cotton damasks for table use. The cotton damasks as made in Spain are wonderful for the exquisite sheen, finish, and beautiful designs.

Viuda de José Tobra, of Barcelona, had an immense exhibit of sheetings and damasks which received a diploma for superior excellence in manufacture, both in regard to material used, which was of the finest, perfection of weaving and finish, and exquisite designs clearly brought out.

The material for bedding shown by a German mill surpassed all others for close, compact weaving, making the most perfect covering for feathers. This exhibitor was Christian Dierig, of Oberlanganbelau, Silesia.

I. G. Grosse, of Saxony, had a superior line of checkered goods. Kreutz & Henke, also of Saxony, a full line of coat and pantaloon stuffs made in the handsomest colors and patterns for these purposes, varying in prices from 11 to 35 cents per yard. From Saxony, too, C. G. Grossman brought fine canvas goods and covers for embroidery, plain and fancy scrims, and a knitted cotton fabric used as a lining to carpets and most excellent for that purpose.

The cotton weaving in Saxony is carried on in two large districts at opposite ends of the country. The eastern one is Lusatia; the other, in Voigtland, is especially known for its embroideries and other fine cotton goods. The cotton and linen industry extends over the whole of south Lusatia. In the course of time, however, cotton has assumed that superiority of position which linen formerly possessed, and hand looms have been largely restricted in their sphere of action, though not altogether driven out of use by power losses. The two most important classes of cotton goods are the coat and pantaloon stuffs; and secondly, the checkered stuffs which are especially used for articles of apparel and aprons as well as for bedding.

Austria's exhibits were very limited. Table covers, bedspreads, towels, and napkins, fitting samples of her great industry, as the class of work was of high order. Austria's manufacture of textiles is at present, in the greatest part, done by machinery, although cottage industry is still of considerable extent. The cotton industry stands naturally uppermost, numbering about 1,900 establishments (among them 633 factories) in Bohemia, Moravia, and Lower Austria.

It is much to be regretted that France and Belgium were hors concours. The cotton goods shown by France were extensive in variety and quantity and perfect in quality. Mixed, unbleached and dyed threads, heavy canvas for sails, large exhibits of cotton flannel, most beautiful in texture, finish, and patterns, and striped and checkered cassimeres for men's and boys' wear. Cotton dress goods, ginghams,

and sateens. One piece of sateen shown by a French exhibitor, the background of dark gray and the design of the French coat of arms, and the coat of arms of the United States in alternate stripes. The handsomest bath robes, most exquisitely embroidered, were shown by a French firm, G. Binder & Jalla, jeune.

Belgium had lamp wicks, ropes very strong, tressed and untressed. Printed cotton tissues in soft colors and flowered designs. Strong domestic fabrics, cotton, and wool goods mixed, shown by Société la dendre. These goods are made in a great variety of colors and sold in large quantities to Canada.

Canada, too, did not compete. She had cotton braids in every color. Canton flannels, tickings, homespuns, sheetings, prints, and ginghams in designs similar to those used of the United States. Canada's statistics show an invested capital in cotton mills of $13,208,121.

In Russia, under Government patronage, the cotton industry has developed very rapidly. It has acquired such dimensions that it not only suffices for home consumption, but exports its products to foreign markets in annually increasing quantities. The origin of the cotton manufacturing industry in Russia, although on a very small scale, dates back to the sixteenth century. The import of eastern productions commenced much earlier. Mons. Longoway, in his excellent review of the Russian textile industry, deduces the fact that the import of manufactured yarns is very insignificant and the production of Russian cotton spinning mills has been 10,000,000 poods of cotton yarns annually. From the statistics given by Thomas Ellison, the number of spindles in Russia is put at 6,000,000 with a yearly consumption of 69.2 poods per spindle. Besides the improvement in quality of cotton goods in Russia in the last twenty years, the manufacture of cheap and heavy goods has developed at the same time, which to a certain extent is able to compete with woolen goods and like prints, and supplies the wants of the poorer classes of inhabitants. The goods exhibited at the Columbian Exposition illustrate not only the progress made, but the present high condition of the cotton industry in Russia. The goods shown were velvets, brilliantines, turkey reds (plain and figured), fustians, calicos, domestics, tricots, and cotton stripes of very fine texture. Buckskins for mens and boys' wear. Bandannas or shawls of gorgeous coloring and design to suit an Eastern market. Cotton flannels, with delightfully soft, even finish, and cretonnes for draperies and curtains in soft grays and browns.

Sweeden's exhibit of cotton goods for heavy draperies was remarkably fine. These goods were rich in design. Hand-woven aprons were shown in a variety of styles and colors, and towels, beautiful and strong in weave. In almost every home in Sweden, however poor it may be, is found a hand-weaving machine at which the inmates almost continually work, and this home "sloyd" has reached such proportions that it may be considered as an industry. Certain capitalists

advance money for the purchase of cotton yarn, which is then woven after certain fixed designs. In this manner from 2,000 to 3,000 women weavers work in their own homes for a single capitalist. Both jacquard and fancy weaving is produced in this fashion. The largest cotton factories are found in Norrkzoping, the Manchester of Sweden. In 1890 there were in Sweden 20 cotton factories, numbering about 245,000 spindles, with a product value of about $3,500,000, and employing about 4,000 work people.

The cotton industry of Italy is a very large and important one in Lombardy, Piedmont, and Venice. A very small display was made by Italy of ginghams and other cotton dress goods, durable and strong in the weaving and with a decided leaning toward bright colors, which was in marked contrast with the Turkish products. Turkish goods are all hand woven in subdued colors, and the combinations were very pleasing.

Japan's cotton goods received many awards. Her exhibits were full and varied, giving a comprehensive idea of the cotton goods manufactured. The most attractive were the dress goods woven from cotton and from cotton and silk mixed. The designs, so pretty and dainty, were mainly little checks and stripes in soft colors. Japan exhibited a cotton cloth for floors particularly noticeable, and a heavy cotton goods intended for overcoats for the poorer classes, and a corrugated cotton cloth used for bath robes.

The firm of F. P. Bumgara & Co., of East India, made an extensive exhibit of cotton wares. The weave of these goods was particularly firm and even, all done by handlooms. The colors were made from Indian vegetable dyes and wash perfectly. Altar cloths with the figures of the national deities reproduced were specimens of this exquisite work. Cotton gauze fabrics with tinsel, table covers in designs similar to those of the Persians, and, above all, the lovely curtains in various sizes, colors, and designs—works of art, showing an inexhaustible fund of native skill in designing and execution by these artistic, ingenious, and painstaking people. Mr. Bumgara's modus operandi has been to unearth models hidden away in ancient temples and tombs.

Persia's exhibit was very meager. Some printed calicoes, Oriental in colors and designs. Plain cotton goods of an even, strong weave, and woven from the brown cotton grown so largely in Persia. All made by handlooms, as Persia has no machinery.

Ceylon imports her cotton from South India, and for the short number of years she has been engaged in the cotton-manufacturing industry shows very creditable fabrics. Five years ago Ceylon established weaving mills—only one steam mill. The dress goods, towels, drills, sheetings, and shirtings and ginghams were of durable weave, and give promise of much in the near future.

Guatemala grows cotton in small quantities, the white cotton and

also the brown, similar to that grown in Persia, but a much finer staple. There is as yet only one cotton factory of importance, but the cotton fabrics exhibited by Guatemala—homespuns and ginghams—were noticeable for strength of material, even weaving, and for the brillant coloring procured from the Indian vegetable dyes.

Bulgaria and Korea have only handlooms. Bulgaria made a very nice exhibit of cotton striped goods for curtains and of a cotton and silk mixed goods, also for curtains.

Korea's exhibits were small and indifferent.

In Brazil the industry seems still in a crude infancy.

Mexico's display of cotton goods was very creditable, both in the heavy domestics and stuffs for pantaloons and coats. One factory at Tulancingo, State of Hidalgo, sent table covers woven in stripes and with fringed borders, remarkable for originality and beauty of designs. Mexico has 93 cotton factories of different classes.

It is not necessary to go back a generation to reach a date at which the cotton plant was so little understood that such by-products as cotton-seed oil, cotton-seed cake and their modifications were unknown. They are worth much more in money to-day than the crop of lint was at that date.

The varied exhibits of the unlimited uses of the lint of this wonderful plant made at the World's Fair emphasized the fact that there has been no abatement of the ingenuity of man in devising new forms into which to convert accumulating material, and points to the deduction that for its benefit the world will consume what it produces.

Probably the best result of this crowning Exposition is educational. A comparison of the exhibits of cotton manufacture, not only among themselves, but with the productions of the past, in the aggregate and in detail, must lead to new uses, new forms, new fancies into which the snowy staple can be wrought.

DIAMOND CUTTING DISPLAY OF TIFFANY & CO., NEW YORK.

BY

J. D. YERRINGTON.

DIAMOND-CUTTING DISPLAY OF TIFFANY & CO., NEW YORK.

By J. D. YERRINGTON.

The exhibit by Tiffany & Co. in the "mines" building of a complete diamond-cutting establishment, employing a force of skilled workmen at diamond cutting, is remarkable; and that this exhibit is appreciated is evinced by the crowd of men and women constantly striving for a sight of the interesting processes of cleaving, cutting, and polishing the diamond. The work at this establishment is faultless. No praise of mine is adequate. One of the strongest attractions of the Fair, it merits the highest award, for nowhere else in the world is there an establishment where such excellent work is done. I saw here pair after pair of diamonds so accurately cut that two diamonds placed in very sensitive scales would precisely balance each other. Such balancing could have been accomplished only by the most careful, patient, and painstaking work.

In connection with the Tiffany & Co. workshop there is the interesting exhibit by the De Beers Company, of South Africa, of tons of diamond matrix from the company's mine, and of the process of washing this matrix for diamonds and of sorting the diamonds after these washings. The De Beers Company also exhibits a large assortment of rough diamonds, including one weighing fully 280 karats, and many smaller ones, notably one large pink and many brown and yellow diamonds, as well as white ones. This exhibit is also a great attraction and merits liberal praise and encouragement by high award.

In the liberal-arts building I found the Tiffany & Co. exhibit of diamonds a great attraction—perhaps the greatest attraction of the Fair. Each day the gates were constantly besieged by a crowd of men and women eager to see this exhibit. Of this diamond exhibit I can only mention those most remarkable:

Empire brooch, with a 16¼-carat blue-white diamond in a floral wreath of small diamonds.

Empire brooch, with an 11⅛ $\frac{1}{32}$-carat brown diamond, with a smaller one suspended from a line of diamonds.

Empire brooch, with a 12¾-carat smoky-black diamond, surrounded by a lily-of-the-val'ey wreath of white diamonds.

Empire brooch, with a 16⅝ $\frac{1}{16}$-carat plum-colored diamond, in a wreath of brilliants, surmounted by a bowknot of brilliants.

Empire brooch, composed of a 16$\frac{3}{32}$-carat yellow diamond in a lily-of-the-valley wreath of diamonds.

Bonnet brooch, with five black and white diamonds, weighing 10$\frac{9}{16}$ carats.

A table-diamond bracelet, with one diamond weighing 3$\frac{7}{8}$ $\frac{1}{32}$ carats, and nearly 8 carats of smaller diamonds, fancifully cut in various forms.

A Rennaissance brooch, with a 6$\frac{3}{32}$-carat salmon-colored diamond, surrounded with brilliants.

A fly brooch, with emerald body, and two pear-shaped diamond wings, weighing 15$\frac{1}{32}$ carats.

A butterfly brooch, with five large pear-shaped diamonds, 18$\frac{1}{4}$ carats, and diamond antennæ.

A Columbus sword scarf pin, with diamond hilt.

A Turkish pendant, made of pendant diamonds in all forms of cutting, several of which are pierced like beads.

A coronet ring, with yellow table-diamond, weighing 4$\frac{3}{32}$ carats.

A necklace of 42 matched and graduated diamonds, weighing altogether 172$\frac{1}{4}$ carats; remarkable for extraordinary brilliancy and for being so nicely mated.

A rope of diamonds in platinum for a necklace, and weighing 19$\frac{3}{4}$ carats.

A chain of diamonds in gold, for a bracelet or a necklace, as its owner may desire to wear it.

A necklace of pearls and emeralds, with 11 old Indian Brioletta diamonds, 108$\frac{7}{8}$ carats.

A Portuguese style diamond necklace, made up of 550 rose diamonds, festooned and pendant.

A canary diamond girdle, with 21 diamonds aggregating 413$\frac{1}{8}$ carats.

A single diamond, weighing 11$\frac{3}{32}$ carats.

Two diamonds, weighing 13$\frac{3}{8}$ carats.

Two diamonds, weighing 11$\frac{1}{4}$ carats.

The great Tiffany diamond, weighing 125$\frac{3}{8}$ carats, and revolving on top of exhibit.

DRAWN WORK.

BY

MARGARET WINDEYER.

DRAWN WORK.

By MARGARET WINDEYER.

This section was represented by exhibits from Austria, Bohemia, Brazil, Canada, Curaçao, Germany, Great Britain, Mexico, New South Wales, Norway, Russia, Spain, and the United States.

Drawn work may be described as follows: Threads are drawn from the woof and web of any suitable material at regular intervals, those remaining being drawn into place with needle and thread to form regular patterns, and lace stitches may be worked into the open spaces thus formed, or the remaining threads are overcast with silk or cotton. The technique differs in the exhibits, one characteristic or other being more prominent in the exhibits from each country. In point of variety of materials and stitches employed, and of varied modes of utilizing drawn work, Mexico stands foremost. In the exhibits from that country we find it in silk and in every quality of muslin, linen, cambric, and lawn, in bordering and in insertion, and adapted to table linen, antimacassars, underclothes, furniture, trimming, and so on. It is exhibited with floral designs, appliqué in self colors, with flowers embroidered upon it in natural colors, and with the drawn work forming the background, the pattern being presented in the whole material.

When the "missions" were built from San Diego to Monterey, and many Spanish families lived upon the coast, drawn work was one of the pastimes of the women members; they taught it to their Indian women servants, who soon became proficient, finishing their bed and table linen in this manner, and the practice has been handed down to the present day. In old Mexico each State has its own stitches, and it is found difficult to persuade workers to copy from examples from other States. Austria's exhibits were chiefly in fine canvas; the drawing out of threads in this material would be easy, but the excellence and variety of the lace stitches introduced, and the effectiveness of the "ivory" embroidery in conjunction, in one exhibit especially was remarkable. The best exhibit of drawn work, shown in such quantity as to justify the term trade exhibit came from Austria. Bohemia's most interesting exhibit was in coarse material, where an effect of round holes was produced.

Brazil showed drawn work in every stage, from the plain material stretched upon a frame to the finely finished floral design. One fea-

ture of the specimens from that country was that where the design was a floral one, threads of a coarser quality than the foundation were darned into the pattern giving greater richness of effect. The floral designs in the drawn work from Curaçao were very well defined; the patterns were produced by "drawing" very small squares and closely filling the spaces in a diamond stitch with coarse cotton. Germany's best exhibits in this class were two samples, one in linen, the other in canvas; the one showed a large number of patterns in drawn work, finished in buttonhole stitch overcasting, and the other presented drawn work where the introduction of lace stitches was the chief feature.

The exhibits from Canada, Great Britain, and New South Wales did not possess much originality, but from New South Wales and Norway came the only exhibits of drawn work, upon material with a diagonal surface; the former's exhibit was in silk, the latter in twilled calico.

The chief characteristic of Russia's exhibits was the use of colors in such a way as to produce a rich effect, though the actual "drawing" was very simple. All the threads were closely overcast in even squares and the pattern produced by the use of different colors.

The exhibits from Spain were exquisitely fine, and the best example of embroidery upon drawn work came from that country. The drawn work in colored linens, the stitches in white thread, among the Spanish exhibits was very effective.

Interesting specimens made by the Temecula tribe of San Diego County, Cal., described in Helen Hunt Jackson's book Ramona, were exhibited; native designs were made by drawing cotton closely into the open spaces. An interesting exhibit was one where the conventional design was departed from and a herd of deer worked into the pattern.

The chief feature in the United States exhibits was the lace-like effect produced, so very many threads being drawn, and the remainder being so lightly overcast, and such very light stitches being filled into the open spaces.

ELECTRICITY.

REPORT ON DIRECT CONSTANT-CURRENT DYNAMOS.

By HENRY S. CARHART, LL. D.,
Professor of Physics, University of Michigan.

I. CLASSIFICATION.

The present report will be restricted to direct-current dynamos as distinguished from those furnishing alternating currents; and, further, to those designed to work with a constant current as distinguished from machines working at a constant pressure or constant potential. Direct constant-current dynamos are used almost exclusively for the purpose of lighting by arc lamps. For while electric motors have been worked to a limited extent on constant-current circuits, this service forms a very insignificant part of the work done by constant-current machines. The transmission of power by electricity is accomplished almost exclusively by means of constant potential machines, either of the alternating or direct-current type. This report will therefore consider constant-current machines of the direct-current type as applied to arc-lighting service exclusively.

The dynamo machine is a device for converting the energy of mechanical motion into the energy of an electric current. The so-called generation of electricity consists always in the production of an electro-motive force or of electric pressure. The quantity of electricity at our command is apparently as definite and invariable as the quantity of energy. No battery, dynamo, or other device creates electricity. It creates electro-motive force, by means of which electricity may be made to flow through conducting circuits.

In the conducting circuit, external to the region where the electric pressure is applied, the electricity flows from a higher electric level or potential to a lower, as water flows from a higher elevation to a lower. Within that part of the circuit where the electro-motive force (E. M. F.) originates, the electricity is forced from a lower electric level to a higher, as water is pumped from a lower to a higher level. In the dynamo machine this latter region is that part of the machine called the armature, which usually revolves between the poles of a powerful electro-magnet.

The dynamo is based on the principles of current induction. It contains a system of conductors revolving in a magnetic field in such a way as to vary continuously the number of lines of magnetic force threading through them. Lines of magnetic force are conceived as running from the north-seeking pole of a magnet round through the air to the south-seeking pole, and as completing the circuit through the magnet itself to the starting point. They are the directions of magnetic force, or the lines along which a single magnet pole is urged by the magnetic influence. They can be mapped out by appropriate means, and they indicate the lines along which the magnetic stress acts.

Suppose a single loop of wire to revolve between the poles of a magnet N. S. (fig. 1), in the direction of the arrow and round a horizontal line as an axis. The lines of force run across from north to south, as indicated by the light lines. The loop of wire in the position shown incloses the largest possible number of lines of magnetic force. When it has revolved through 90°, or a quarter of a turn, the lines of

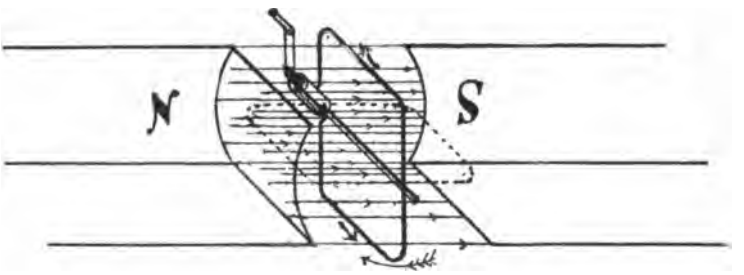


FIG. 1.

force will be parallel to its plane and none will thread through it. During this quarter turn the number of lines has been decreasing and a direct current has been produced; that is, one in the direction of watch hands, looking from north toward south, as shown by the arrows. During the next quarter turn the lines will increase again, but will run through from the opposite side of the loop. According to the laws of induction, the current will therefore continue to flow in the same direction around the loop. During the next half revolution the current round the loop will flow in the opposite direction. The current through the loop reverses twice, therefore, in each revolution. Such a loop constitutes a single turn of wire on the armature of a dynamo machine; and the current within the armature is in general an alternating current; that is, it flows first in one direction and then in the other in rapid succession. To render these currents unidirectional a commutator is necessary.

The three essential elements of a direct-current dynamo machine are therefore the field magnet, the armature, and the commutator. The field magnet is a large electro magnet whose function is to produce

a powerful field of magnetic force between its poles; within this field of force revolves the armature, which in direct-current machines always consists of a soft-iron core wound about with a number of turns of insulated copper wire. To the shaft of the armature is rigidly attached the commutator, which is cylindrical in form, and consists of a number of metallic bars lying parallel to the axis, insulated from one another, and appropriately connected to the several coils of the armature. Brushes for conveying away the current bear on this commutator in such a way that, when one end of an armature coil is electrically connected to one of these brushes, the other end is connected with the other brush; and these connections exchange during the rotation of the armature at the same time that the current reverses direction in the coil.

The field magnets of all dynamo machines employed for arc lighting in the United States, with one exception, are of the consequent pole type; that is, each pole is a part of two complete magnetic circuits. Until very recently they have all been, moreover, bipolar; but quite recently multipolar machines have been introduced for dynamos of extraordinarily large capacity.

The manner in which the armature is wound and connected to the commutator forms the basis of classification for unidirectional constant current dynamos. The two classes are known as the open-coil and the closed-coil machines. In the former the coils on the armature are connected, either all together or in pairs, by means of one of the extremities of the coils, while the other terminals are brought out separately and connected each to a separate bar of the commutator. The wire of the armature does not, therefore, form a closed circuit, but is an open one, because the several commutator bars are insulated from one another. An electric circuit is formed only when the brushes, which are connected to the external circuit, bear on the commutator cylinder.

In closed-coil machines the windings on the armature are all connected together in series and form a closed electric circuit within the armature itself. The junction of every pair of adjacent coils in a two-pole machine is connected to a commutator bar, so that there are as many commutator segments as there are sections in the winding of the armature. This number varies in modern machines from 36 to 234.

In open-coil machines each coil is periodically cut out of the circuit, or is put in parallel with another coil a number of times during each revolution of the armature. In closed-coil machines all the windings on the armature are continually in circuit; and, since the current flows out of the armature by one brush, and after passing round the external circuit, flows into the armature again by the opposite brush, the two halves of the armature form a divided circuit in parallel with each other from brush to brush. In the open-coil machine the wire on the

armature must, therefore, be large enough to carry the entire current furnished by the machine, usually ten amperes or a little less; while in the closed-coil dynamo the wire on the armature must be large enough to carry only one-half the total current because of the divided circuit through it.

In open-coil machines the number of sections on the armature is limited, ranging from 3 in one type to 24 in the large multipolar machine of another type. In closed-coil armatures the number of sections is much larger, running as high as 234 in a large machine of recent construction. The field magnets of both the open and the closed coil dynamo are excited in the same way. They belong to the class known as the series-wound dynamo. The connection of the field magnet with the armature is shown diagrammatically in figure 2.

The entire current flowing out of the armature by the positive brush

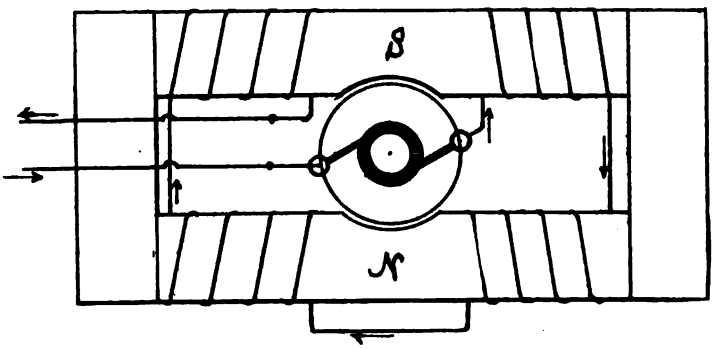


FIG. 2.

passes around the windings on the field magnet, then traverses the external circuit and returns to the armature by the negative brush. There is no reason why the field magnets of dynamo machines for arc lighting should not be separately excited from an independent source. Indeed, this method has been adopted in a recent machine to be described later on. It has the advantage of giving to the dynamo additional capacity, and the disadvantage of adding to the fire hazards and danger to life in case of a breakdown in the circuit. If the machine is self-excited it ceases to generate electro-motive force and loses its excitation when the circuit is open, but if it is separately excited it continues to generate electro-motive force or electric pressure after the main circuit is accidentally opened. It is possible, of course, to avoid any serious consequences by means of a device which shall automatically open the exciting circuit whenever the main circuit is opened by accident or otherwise.

II. Open-Coil Dynamos.

As already explained, open-coil armatures are constructed so that the separate coils or sections of the winding are not united together into one closed circuit. A ring armature, for example, may be wound in sections so that each pair of sections has a separate commutator or collector. Figure 3 shows a ring armature with two pairs of coils and a four-part collector.[1] Each coil is joined at the back to one diametri-

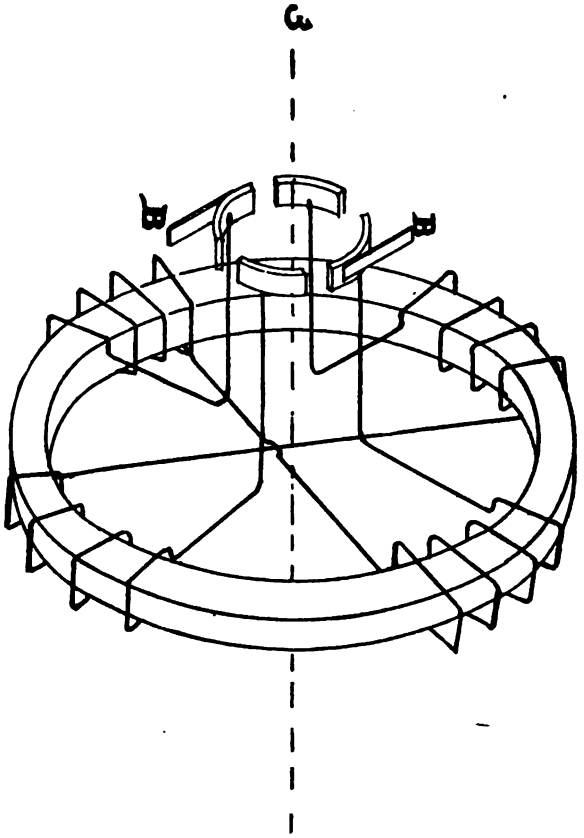


Fig. 3.

cally opposite it, and only the front ends of the coils pass to the collector. It would make no difference if the wires at the back were all united where they cross. It is obvious that as this armature rotates between the poles of the field-magnet, but one pair of the coils will be in action at once, the other pair being cut out of the circuit for the time being. It is possible to increase the number of coils and the number of parts of the collector, and to so connect them that only one

[1] Thompson's Dynamo-Electric Machinery, p. 450.

pair of coils is joined to the brushes while passing through the position of maximum action, all the rest being at the same time on open circuit.

In figure 4 the wavy line A C represents one pair of the coils shown in figure 3. The maximum inductive action is supposed to be in the vicinity of the line m m'. This line, instead of being drawn directly across from one pole face to the other, is shifted forward in the direction of rotation, because the magnetic field of the dynamo is distorted by means of the armature as an electromagnet. The brushes P P' are made to bear upon the commutator or collector along the line m m', that is on the line of greatest action. It will be seen that the coils A C only are in circuit, while B and D are idle. It is clear that each coil is in action through an arc of 90°, or 45° on each side of the line m m'. As one pair of coils passes out of action the other pair passes into the circuit, with a momentary break of current and a spark as the two successive segments pass under the brush, unless the brush has sufficient overlap to touch both segments at once. A little consideration will show that while the current in the coils of the armature are alternating, the brush P is always the positive one and P' the negative, so that the current in the external circuit is direct or unidirectional.

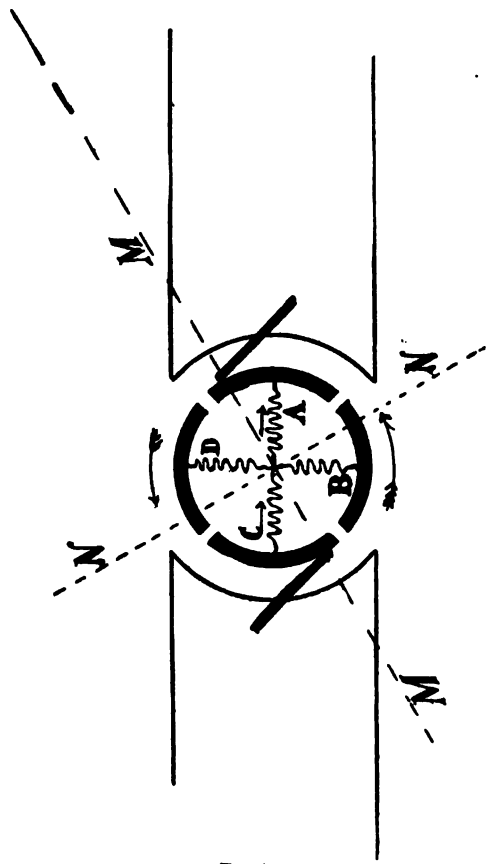


FIG. 4.

It is easy to arrange the contact of the brushes, by making each brush consist of a connected pair, for instance, so that they can make contact with one set of segments before leaving the other. The two sets of coils are then, of course, in parallel, and the electric resistance of the armature is reduced to one-half. Unless the idle coil is cut out when it approaches the position of least effect there will be a useless back

flow of current through it, for the two coils are not equally active while they are in parallel, except at the instant when they make equal angles with the m m'. In all other positions the higher electro-motive force of the more active coil overcomes that of the less active, and the two coils constitute a closed circuit by means of the overlapping brushes. The electro-motive force at the brushes is then less than if the two coils were not in parallel, and the local current through the coils heats the armature. It may be remarked here that the reduction of electro-motive force by putting the coils in parallel is utilized in one or two machines for the purpose of regulation with a diminishing load, for when the number of lamps alight on the circuit diminish, the electro-motive force must also be lessened in order to maintain a constant current. It is easily seen that a change in the spread or overlap of a brush, consisting of two parts, may be utilized to regulate the electro-motive force of an open-coil dynamo by changing the interval of time during which two coils remain in parallel.

THE BRUSH DYNAMO.

To Mr. Charles F. Brush, of Cleveland, Ohio, belongs the credit of inventing a constant-current dynamo which, in connection with his system of arc lamps in series, created the arc-lighting industry of America. The invention of the Gramme ring in 1870 introduced a new era in the application of electricity to industrial purposes. Mr. Brush built his first arc dynamo in 1875–76. Its armature is a Gramme ring, but it is so modified as to make an open-coil machine of very remarkable and ingenious construction. The Brush Electric Company was incorporated about 1877, and commercial arc-lighting dates from the following year, when a series of arc-lighting plant was installed in Boston, and the first arc-lighting station in the world was projected in San Francisco. Five years later there were Brush lamps burning in more than five hundred isolated plants, while more than fifty central stations were in operation. At the same time over two hundred Brush dynamos were in use in England and on the Continent.

Some of this early apparatus was exhibited in the Brush section at the World's Fair, notably a dynamo that had been in constant service from September 1, 1879, to April 10, 1893, "With no expense for repairs except for segments and brushes, the expense for which has been light." A second machine was exhibited which had been secured from the Berkeley Company, of Providence, together with a certificate to the effect that this dynamo had been running constantly since December 1, 1881. It was a ten-light machine; and the ten lamps, which had been in continuous service without repair since that date, were also exhibited.

This earliest practical dynamo is still, with but slight modifications,

an important factor in the arc-lighting industry of the present day. It is built in sizes with a capacity ranging from one to one hundred and twenty arc lamps.

The complete machine is shown in figure 5. The armature revolves

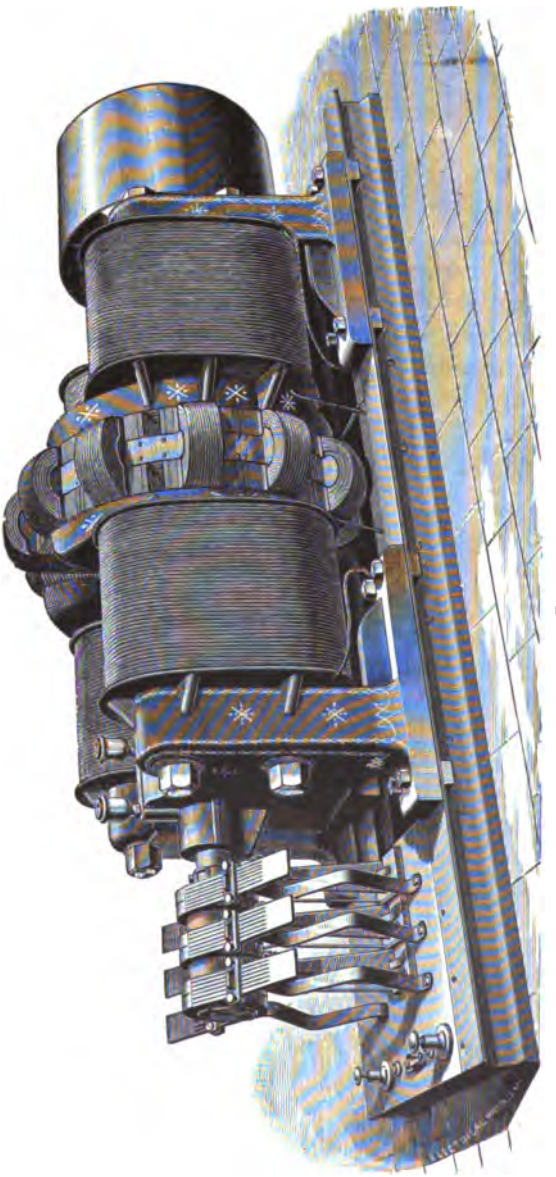


FIG. 5.

between the extended and curved pole pieces of two horseshoe-shaped electromagnets, their windings being so connected as to make the poles on one side of the machine north, and on the other side south poles. The wire is insulated from the iron of frame and armature

by shellacked paper and gum cloth, mechanically strengthened in certain places by canvas, also well shellacked. To prevent the insulation of the magnets being punctured by the extra current that would be induced by any sudden rise or fall in the magnetism of the cores—such, for instance, as opening the circuit under full load—the cores are surrounded by a copper sheath next to the mica, forming a circuit of low resistance, in which the extra current can expend itself harmlessly.

The armature is a ring, not entirely overwound with coils, but having projecting pieces between them, like the Pacinotti ring. The ring itself was formerly made of malleable cast iron, but in the newer

FIG. 6.

Brush machine it is built up of thin iron rings 1.5 millimeters thick. A portion of such a built-up core may be found in figure 6. The coils are wound in the spaces B B. This construction has the advantage of ventilation of the armature, and a great reduction of induced currents in the iron core, which absorb energy. The result is a marked increase in the capacity of the machine. A machine which formerly supplied forty arc lights with the old armature can carry sixty-five lamps with the new ring rotating at the same speed.

The armature of the bipolar Brush dynamo of figure 5 is wound with either eight or twelve coils, according to the size and capacity of the

machine. For each pair of coils there is a separate two-part commutator. The eight-coil armature requires four commutators, grouped in two pairs, and two sets of brushes. The four commutators are arranged in pairs side by side, and each brush is wide enough to touch at the same time the commutators of two pairs of coils. Adjacent commutators are connected with two pairs of coils situated at right-

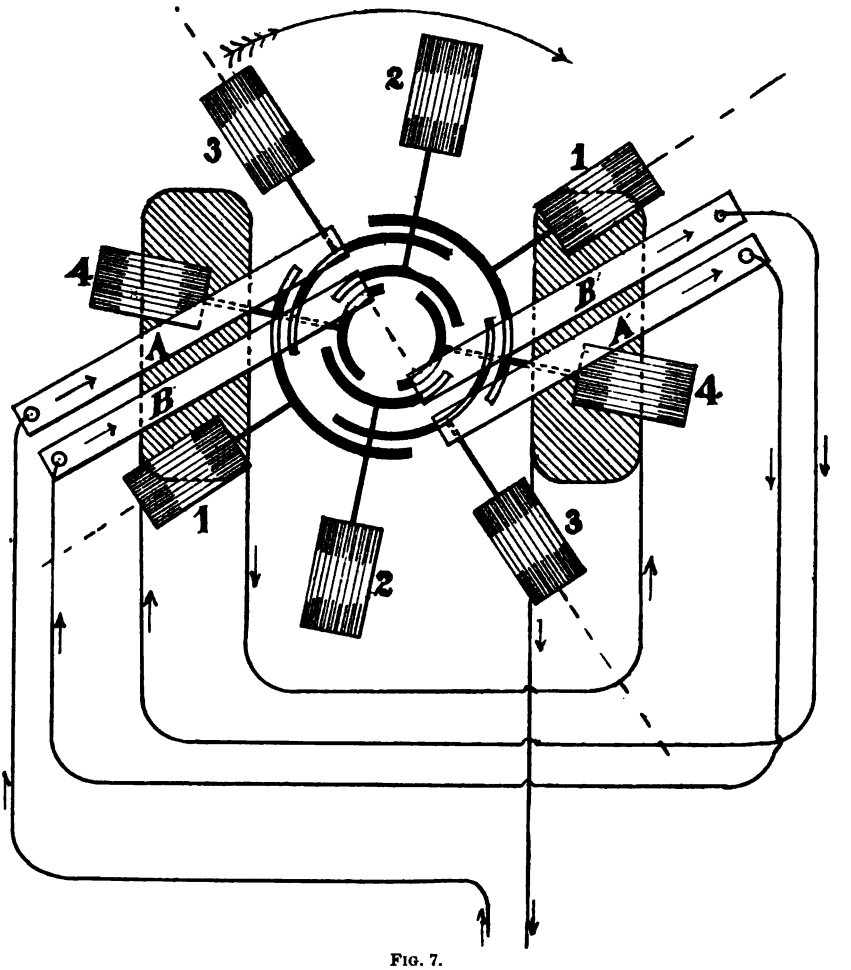


FIG. 7.

angles to each other on the ring. Continuity of current is secured by making each pair of commutator segments overlap to the extent of 45°.

The arrangement of coils and commutators may be understood by studying figure 7.[1] The eight coils are connected in four pairs at the back by means of wires not shown in the diagram. The outer ends of the coils are connected to the corresponding commutator segments

[1] Thompson's Dynamo-Electric Machinery, p. 459.

by means of insulated conductors carried through the shaft and the journal at the commutator ends of the machine. Each pair of coils, as in 1 1 in the figure, is cut out as it passes through the position of least action; that is, the position in which the rate of change of the lines of force through it is a minimum. Neither of the brushes touches the commutator segments of the coils 1 1 in the position shown in the diagram. The coils 3 3 on the other hand are in the position of best action, and the brushes A A′ touch the commutator segments of these coils only. Coils 2 2 have just passed the position of best action, while coils 4 4 are approaching this position. The induction in them is therefore less than in 3 3, and the brushes B B′ are accordingly arranged to press upon the commutator segments of both pairs of coils, thus putting them into the circuit in parallel. For the position of the armature shown in the diagram, the course of the current is as follows: Starting at the negative brush A, it passes into the coils 3; thence out by the positive brush A′, and round by the connecting wire to the other negative brush B; thence through the coils 2 and 4 in parallel and out by the other positive brush B′; thence round the field magnets, out to the external circuit, and back to the starting point at the negative brush A. From the description it will be evident that the four pairs of coils of this machine constitute four separate machines; and that these independent machines are united in pairs by the device of letting one pair of brushes press against the commutators of two pairs of coils. These paired machines are then connected in series by bringing a conductor round from brush A′ to brush B.

When the armature has rotated through 45° from the position shown in the diagram; coils 2 2 will be cut out, 3 3 and 1 1 will be in parallel, and these will be in series with 4 4, which are now in the position of best action. Each pair of coils therefore is in succession the position of best action, in parallel with another pair situated at right angles to it, and, finally, cut out of the circuit.

The larger sixty-light Brush dynamos have twelve coils in the ring connected in six pairs. There are three pairs of brushes and three pairs of commutators, each pair being set one-twelfth of a circumference in advance of the next pair.

The largest dynamo exhibited by the Brush Electric Company at the World's Fair was a four-pole machine, with a capacity of one hundred and twenty arc lights in series, at a speed of 525 revolutions per minute. It produces the enormous electro-motive force of 6,250 volts, with a constant current of 9.6 amperes. It is designed to be self-regulating, and will operate from one lamp to one hundred and twenty or one hundred and twenty-five without varying the current more than 0.1 of an ampere. The armature is 34 inches in diameter, and is pro-

vided with twenty-four bobbins, instead of twelve, because the field has four poles instead of two, as in the older machine.

The armature bobbins are connected in a peculiar manner. In the armature with twelve coils each coil is joined to one directly opposite at an angular distance corresponding to the angular separation of the two poles of the field magnet; the corresponding commutator segments are likewise situated on opposite sides of a circle. In this large 4-pole machine, a shaft wire leads from a commutator segment to a bobbin on the armature; this bobbin is connected to the bobbin one-quarter of a circle distant; this one is in turn connected with the next bobbin on the quarter, and this one finally to a third bobbin on the quarter; from this fourth bobbin a shaft wire is brought to the commutator segment on the same ring one-quarter of a circumference in advance of the starting point. The four bobbins are thus joined in series, and are connected with two commutator segments on the same ring, these segments being placed at right angles to each other. The angular separation of the connected bobbins and of their commutator segments is therefore the same as that of the field poles of opposite sign. The relation of armature bobbins, field-magnet poles, and corresponding commutator segments is therefore the same as in the bipolar machine. There are three rings to the commutator and four commutator segments to each ring, making twelve shaft wires, the same as in the sixty-light machine with twelve bobbins.

The field magnet of this dynamo is the same as that of the older Brush machine, except that there are four double or consequent poles instead of two. The pole pieces are presented to the sides of the ring, the same as in the two-pole type. A high electro-motive force is secured with a slower speed, because there are four bobbins in series on the armature instead of two, as in the smaller machines. The weight of the machine complete is 9,590 pounds, which is less than double the weight of the sixty-light machine.

An automatic regulating device is attached to the frame of the machine underneath the commutator, and is arranged to shift the brushes to the proper position for any given load, and it adjusts at the same time a resistance placed in shunt to the field. This mechanism, which is driven by power from the shaft of the dynamo, is controlled by a delicate relay adjusted to keep the current constantly at 9.6 amperes. The bearings are self-oiling; and, since the field is of the four-pole type, there is no stray field or magnetic leakage across the hub or shaft; and therefore there is no heat produced there by this magnetic leakage, as in the older type of large machines. The insulation of the machine is such as to stand a pressure of 10,000 volts without liability of breakdown. Figure 8 is a characteristic of this machine taken by a committee of judges of award. The volts measured at the terminals of the machines are plotted as ordinates, and the corresponding currents in amperes as abscissas. The machine was run at a reduced

speed of 474 revolutions per minute, and the brushes were set in a position for least sparking before each reading. This dynamo has, therefore, the drooping characteristic which is considered so desirable for an arc-lighting machine.

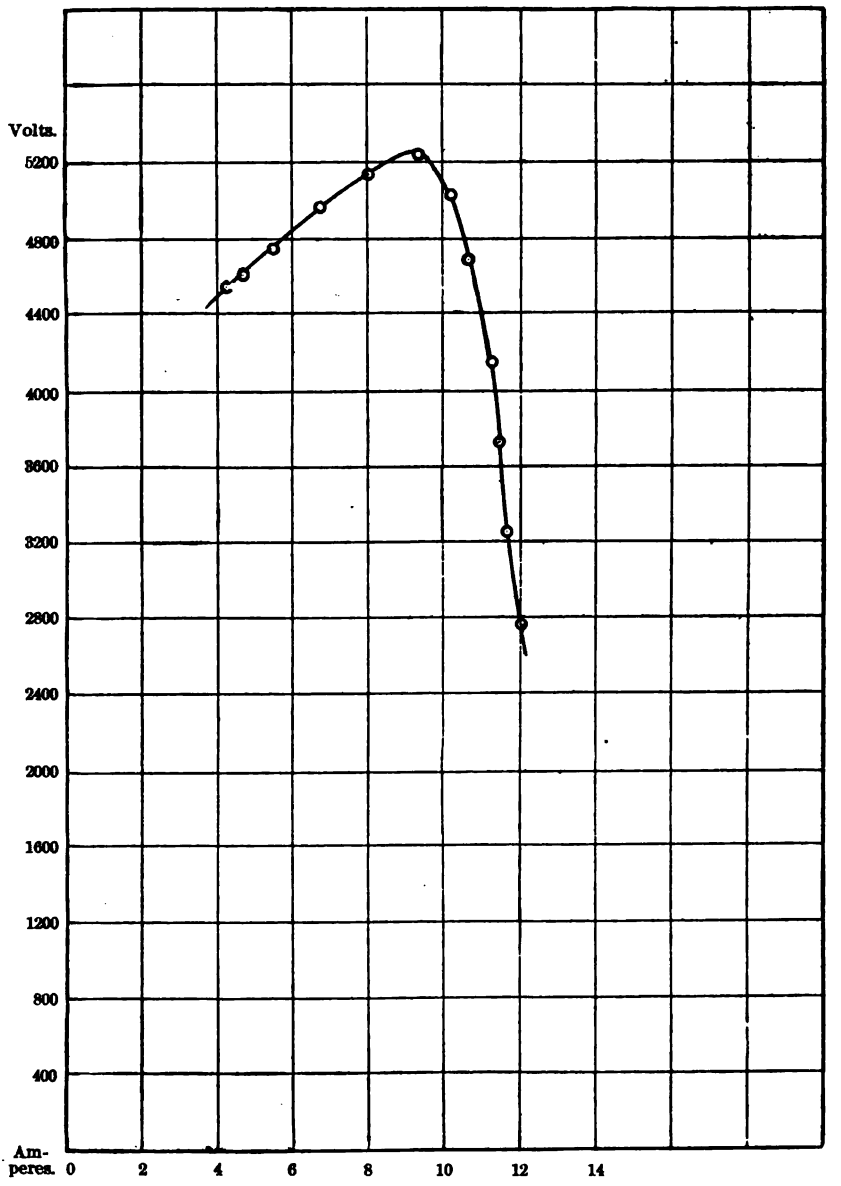


FIG. 8.

The regulator of the Brush dynamo is arranged to control the current by connecting a shunt of variable resistance across the field magnets. Whenever a lamp is cut out, either purposely or by accident, the current rises and the resistance of the shunt is automatically

reduced. This allows more of the current to flow through this bypath around the field-magnet coils, and hence, as less current flows through them, the magnetic excitation of the field decreases. A decrease of electro-motive force follows, reducing it to the demands of the circuit in order to maintain the current constant.

The operation of the regulator may be gathered from figure 9. The wires of the shunt circuit are connected to the binding posts J J, while

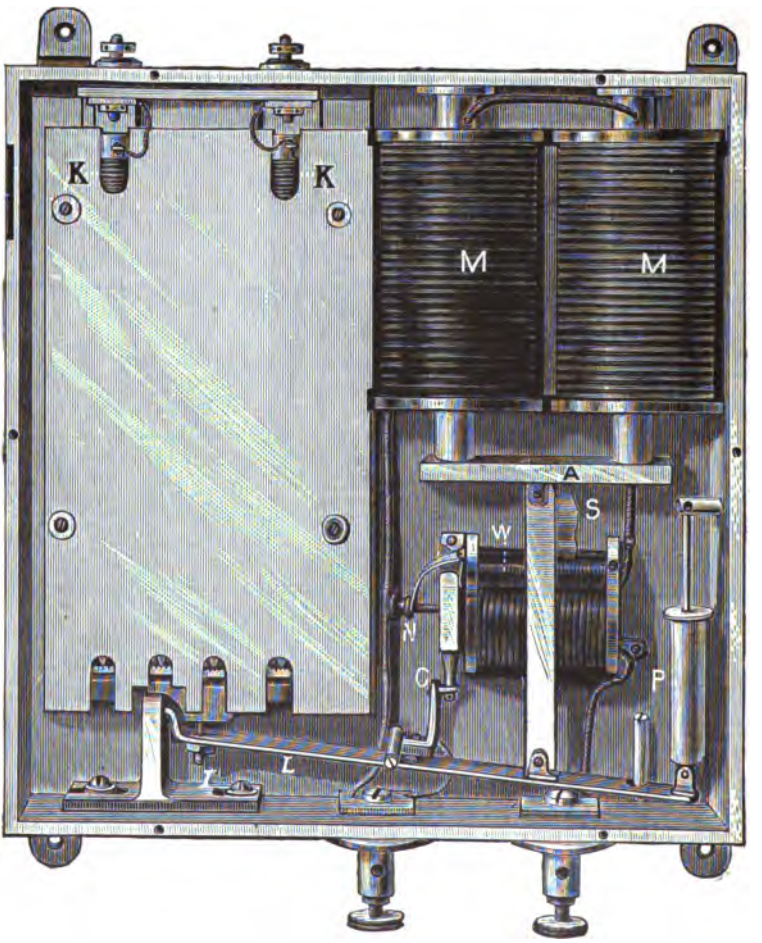


FIG. 9.

the main circuit wires go to B B. The variable shunt resistance consists of four columns of hard carbon plates. The tops of two of them are shown at K K. The control of this resistance is exercised by the main circuit solenoids M M, with their associated cores, connecting bar, and lever L. Whenever the main current rises above its normal value the cores are drawn up by the solenoids, and the lever L rises and compresses the two carbon plates together. This compression

reduces their resistance, and hence more current is shunted from the field magnets through the plates. The vibrating shunt through the German-silver wire W diverts more or less of the main current from the solenoids for the purpose of adjustment. The effect is to cause the pressure exerted on the carbon plates to oscillate about the required value. By this means the load on the dynamo may be reduced even to short circuit, if at the same time the brushes are rocked forward to prevent injurious sparking. More current will be deflected through the carbon plates as lamps are switched off, and the plates will become very warm. They are covered, however, by a slate slab, and the heat does no harm.

For any considerable change in the load of a Brush machine it is necessary to adjust the brushes manually to assist in the regulation and to avoid injurious sparking and flashing around the commutator. The regulation is affected by the conjoint action of the shunt and the rocking of the brushes. An inspection of figure 7 will show the effect of a forward movement of the brushes. When the brush is rocked forward the electro-motive force of the machine falls. If the brushes are in advance of the line of best action, then any pair of coils, as 3 3, may remain in parallel with another pair until the former has reached its position of greatest action and the latter has approached or entered the neutral region. The short circuit through the parallel coils reduces the effective electro-motive force supplied by the most active coils for the external circuit. It will be recalled that the regulator of the four-pole dynamo not only automatically controls the variable shunt resistance, but rocks the brushes to the proper position as well.

The mechanical construction of the Brush arc dynamo has always been one of the chief features which commend the machine to investors in electric-light machinery. The design is extremely simple, and there are but few wearing parts. The armature can be taken out of its bearing without disturbing the field magnet by simply removing four cap screws and two caps. The entire design, it may be said, is a model of mechanical skill and workmanship.

THE THOMSON-HOUSTON DYNAMO.

Following closely upon the Brush dynamo came the Thomson-Houston, altogether another pattern of open-coil machine. Most of the arc lighting of the world has been done with these two machines up to within a very few years. A large number of Thomson-Houston dynamos of different capacities were exhibited and operated at the World's Columbian Exposition.

This machine was designed by Professors Elihu Thomson and E. L. Houston, of Philadelphia. It has two field-magnet cores placed horizontally with their opposite poles facing each other. Each core is a cast-iron tube, flanged at both ends, and furnished at the inner ends

with a hemispherical cavity, within which revolves the spherical armature. A cross section of one of the field cores is shown in fig. 10.[1] The two field cores are connected together by a number of heavy wrought-iron bars bolted to the outer flanges. The wire is wound between the flanges at the ends. In the middle of each concave pole face is a large round opening. This serves partly for ventilation and partly to reduce the density of the lines of force near these centers, so as to render the induction more nearly uniform about the arc of the pole face traversed by the brushes in regulation. This point will be treated at greater length under closed coil dynamos.

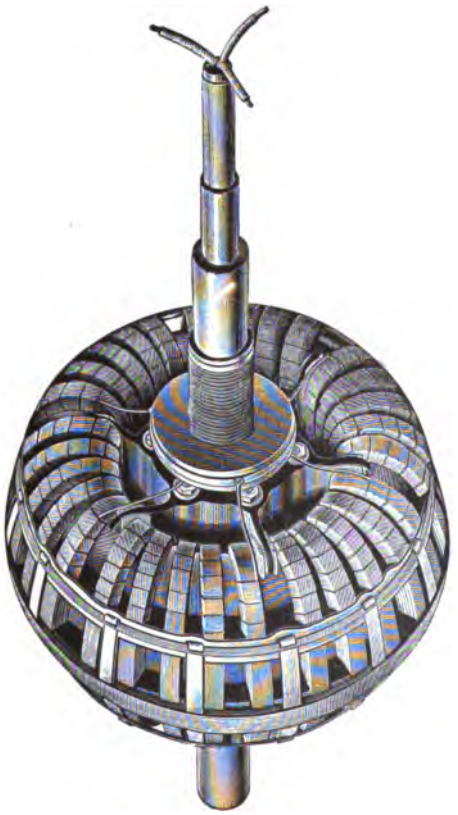


FIG. 11.

Figure 11 shows the armature. It is a Gramme ring wound in a good many sections, but these sections are joined together in such a way as to make only three separate coils. The inner ends of these coils are united together at the pully end of the shaft, while the three outer ends are brought out on the commutator side and are connected to a three-part commutator shown in figure 12. The older armature of this machine was wound round and round, drum fashion, in three coils, which were then connected together and to the commutator in the same way as in the case of the new armature. The latter is better ventilated and admits of easy repair in case of a burn-out.

When this armature is rotated within the spherical cavity between the concave field poles, an alternating electro-motive force is generated in each of the three coils. Diagram, figure 13, will illustrate the method of combining the three coils together so as to secure a direct, though fluctuating, current in the external circuit. The three coils are represented by the wavy lines A B C. There are two positive brushes, P and F, and two negative ones, P′ and F′. The course of the current-flow through the field magnets F M, and the external circuit with the

[1] Not furnished.

lamps L L, is apparent without further explanation. The induction in the armature is such as to cause an outward flowing current in A and an inward one in C, and these two coils are accordingly in series, while B, which is in the region of least action, is out of circuit. A twelfth of a turn later both B and C will have inwardly flowing cur-

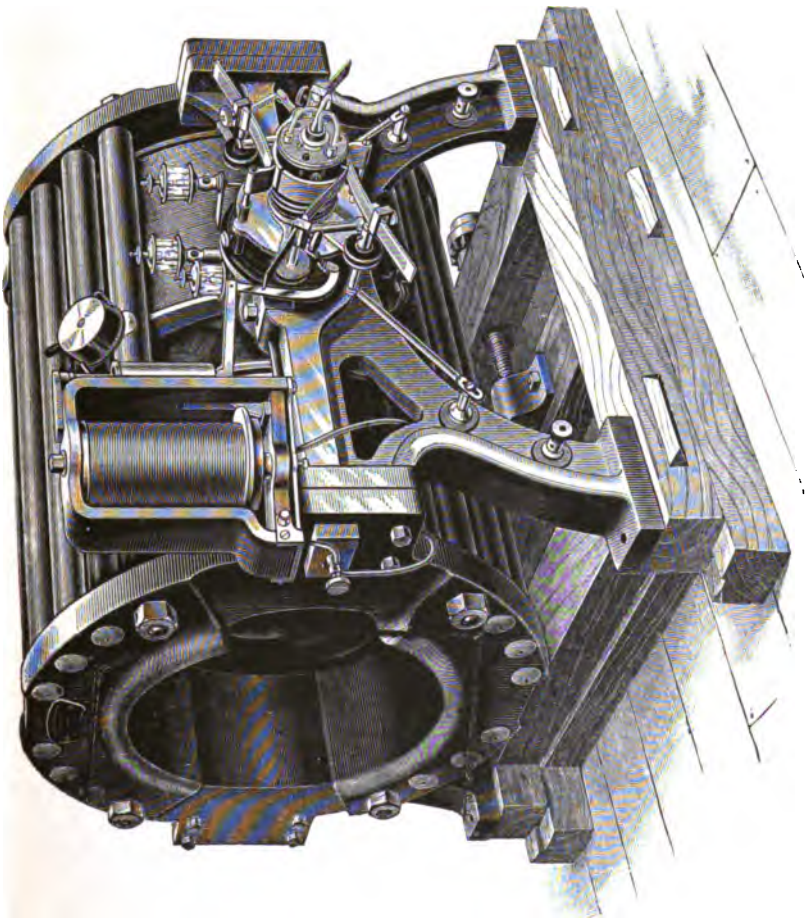


FIG. 12.

rents in them, and will be connected in parallel by F′ bearing on B's segment and P′ on C's. Hence B and C will be in parallel with each other and in series with A. After another twelfth of a turn C will be cut out, B will approach the region of greatest effect and will be in series with A alone. It is evident, therefore, that during one revolution each coil is cut out twice, is twice in series with each of the other coils, is twice in series with the other two in parallel, and is twice in parallel with each of the other two.

The regulation of the current with a varying load is accomplished by automatically shifting the brushes and changing their spread or

overlap. The method used is termed "backward" regulation. The trailing members F F′ of the two pairs of brushes are shifted backward for a diminishing load, while the leading members P P′ are shifted forward through one-third of the angle. If now each pair of brushes has a normal overlap of 60°, then the two pairs are exactly 120° apart on each side. No coil will then be cut out, but one will always be in series with the other two in parallel. If the spread is less than 60°, then each coil will be cut out a short time twice in every revolution. If, on the contrary, the overlap exceeds 60°, the interval between the positive and negative brushes will be less than 120°, or less than the length of a commutator segment. Hence the armature coils will be momentarily short-circuited six times during each revolution. The time during which each coil in the best position is throwing its entire electro-motive force into the circuit is also shortened, and the time during which it is in parallel with a comparatively idle

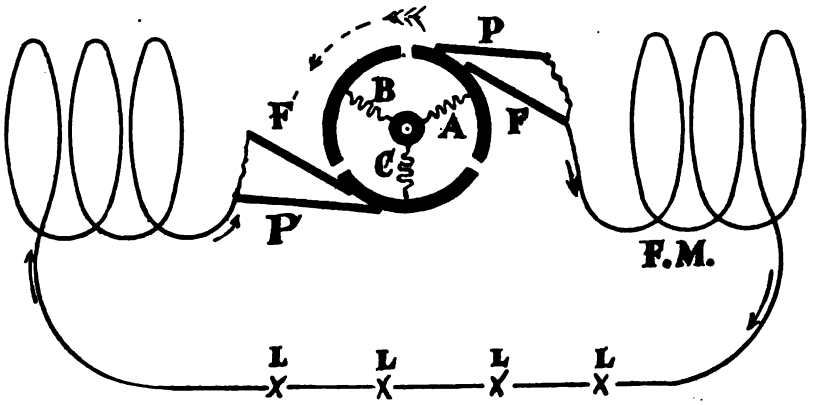


FIG. 13.

coil is increased. Hence the increased spread of the brushes, due to a backward shifting of the trailing members and the forward shifting of the leading members, has the effect of reducing the total electromotive force of the machine. The machine thus accommodates itself to a smaller load with fewer lamps.

It remains to describe the regulator mechanism. Its principle is shown in figure 14. The electromagnet R and its armature A constitute the motor mechanism to move the brushes. It is attached to the frame of the dynamo as exhibited in figure 12. Another magnet, consisting of two solenoids, is called the controller magnet. It is placed in the main circuit and its cores are supported in part by a spring. The yoke of these cores operates the contact lever S. If the current becomes too strong, the cores of the controller magnet are drawn upward, thus opening the circuit at T and causing the entire current to flow through the motor magnet R. This, then, draws up its arma-

ture toward its conical pole, and, by means of a system of connected levers, shifts the brushes so as to increase the overlap and cut down the electro-motive force. The cores of the controller magnet again drop, the break at T closes, and the magnet R is again shunted. This operation is repeated at short intervals, giving a gentle vibratory motion to the brushes about the mean position required for regulation. A carbon resistance r is inserted to lessen the spark at the contact T.

Open-coil machines necessarily spark a good deal. This is especially true with a three-coil armature. The sparking is due to self-induction, or that property of electricity, analogous to inertia in matter, by virtue of which a current when once started tends to continue flowing, and by which electricity opposes resistance to an electro-motive force which tends to set it moving. It is in reality a self-induced electro-motive

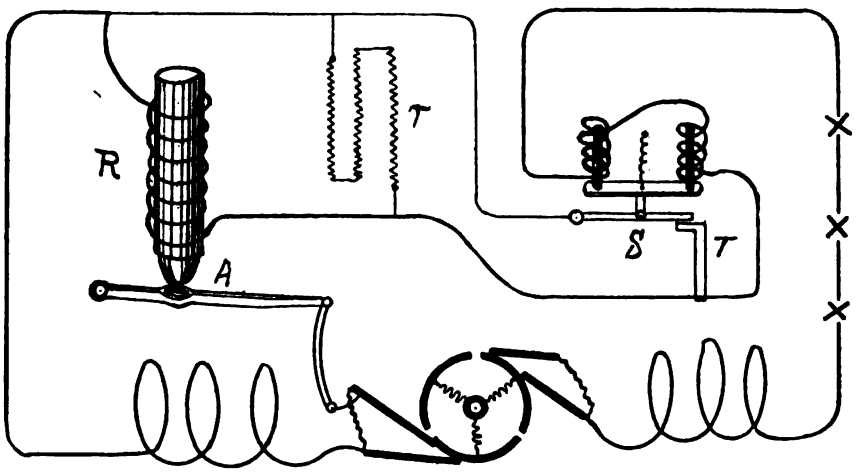


FIG. 14.

force, arising from the change in the number of lines of force surrounding or linked with the circuit, whenever a change takes place in the strength of the current. Whenever a current is sent through a coil, especially if it is wrapped around iron, the lines of force produced by it and linked into the circuit produce a counter electro-motive force in the very act of their coming into existence. When the current is diminished or withdrawn, the collapse or disappearance of these lines of force produces another electro-motive force in the coil, which prolongs the current on opening the circuit by the production of a spark at the gap, across which the current flows as a momentary arc.

Now the larger the number of turns of wire wrapped around an iron core the greater will be the electro-motive force of self-induction on making or breaking a given current. In dynamo machines designed for arc lighting a great many turns of wire on the armature are nec-

essary for the purpose of producing the high electro-motive force necessary to maintain a considerable number of lamps in series. And when all these turns of wire are divided into from three to twelve sections only, each section or bobbin contains a large number of turns. It is therefore evident that the electro-motive force of self-induction is greater than if there were a larger number of bobbins on the armature. This high electro-motive force of self-induction shows itself in an open-coil machine whenever a segment of the commutator passes out from under the leading brush by the production of a brilliant spark. This spark may be minimized by a proper setting of the brushes for each load, but it is hardly possible to get rid of it entirely in an open-coil machine. This is especially true when the coils are reduced to the small number of three. The difficulty is met in the Thomson-Houston machine by attaching a blower to the armature shaft at one side of the commutator. This blower delivers a blast of air in a thin sheet on the commutator just in front of the leading brushes. By this means the spark is so reduced that it does little or no harm to the commutator.

The fluctuations of the current in open-coil armatures increases as the number of coils in the armature diminishes. The cutting out of idle coils and the self-induction due to any electro-magnets in the circuit tend to tone down the rapid fluctuation and steady the current, but the fluctuations of the current in a three-coil armature are still very marked. Mr. M. E. Thompson has made a special study of a Thomson-Houston arc-light dynamo, the main current of which was 6.8 amperes, and has found that the current at full load fluctuated between 5 and 8 amperes 6 times in each revolution. The fluctuations of electro-motive force in each coil were still more marked, its value falling to near zero 12 times in each revolution.[1] The influence of such a fluctuating current on neighboring telephone lines is shown by the loud buzzing sound heard in the telephone. It is sometimes claimed that such fluctuating currents have certain advantages when applied to arc lamps, because of the vibratory effect which these fluctuations communicate to the lamp mechanism. These vibrations facilitate the feeding of the lamp by preventing the parts of the mechanism sticking. But such is the perfection attained in modern arc-lamp mechanism that they operate perfectly and noiselessly with an absolutely constant current. The rapid fluctuations of electro-motive force in an open-coil dynamo bring great strains to bear upon its insulation. The commutators employed are, however, of the best possible design to meet this strain. They are simple in construction and easily repaired when necessary. Open-coil dynamos have done splendid service in arc-lighting in the past, and they give good promise of dividing the work with closed-coil machines in the future.

[1] Electrical World, XVII, p. 392, 1891.

THE WESTINGHOUSE OPEN-COIL DYNAMO.

A new machine for direct constant currents has been designed by the Westinghouse Electric and Manufacturing Company on the same lines as their constant current alternating machine. The field of this new dynamo consists of a circular cast-iron yoke with six inwardly-projecting pole pieces. The yoke parts in a horizontal plane along a diameter. The lower half, the bearings, and the bedplate are all cast in one piece. The six field coils are connected in series and are separately excited. The drum armature is of the toothed type with lathe-wound coils, heavily insulated.

A novel feature of this machine is the method of commuting the

FIG. 15.

current. The armature has eight teeth, and the windings on opposite teeth are connected in series. There are therefore eight terminal wires. The commutator consists of two parts placed side by side, each part consisting of four spiders fitting into one another, but thoroughly insulated, and each spider composed of three contact surfaces or segments. The eight terminal wires of the armature coils are joined to the eight spiders of the commutator. The segments of one commutator are opposite the insulation on the other.

Each brush has two members to bridge over the insulation between the segments of the commutator, and one pair of brushes is in series with the other pair. The complete machine is shown in figure 15.

The most noticeable feature of this dynamo is its capability of inher-

ent automatic regulation from no load to full load without the use of any devices external to the machine itself. This is accomplished entirely by the reactive effects between the armature and the field and without shifting of brushes. This is the distinguishing characteristic of the constant current alternating dynamo brought out by this same company several years ago, the chief difference between the new machine and the alternating one being that commutators are substituted for collecting rings. It is claimed that this generator shows an efficiency of 90 per cent. It is built in sizes of 25, 40, and 60 lights capacity.

III. Closed-coil Dynamos.

Open-coil dynamos secured the field at an early day in the development of the electrical industry of arc lighting through the inventive genius of Mr. Charles F. Brush and the splendid ability of his business associates. This success was repeated a little later by the equally

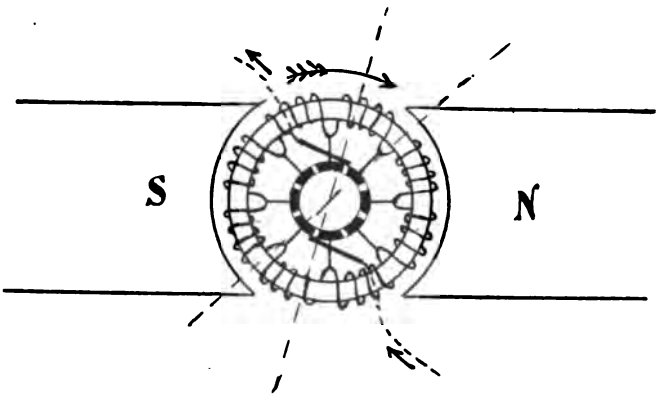


Fig. 16.

brilliant achievements of Professors Thomson and Houston and the phenomenal management of the company formed to exploit their patent. Aside from any question of inferiority, it is therefore easy to see why the closed-coil dynamo for constant currents has remained so long in the background. It has not received the attention to which it is entitled, and has not been investigated with the thoroughness and skill which it merits. Its theory has not been understood, at least, until quite recently. It is not my purpose in this report to draw comparisons between open and closed coil armatures. The former is entitled to that consideration which long continued and satisfactory service in public and private illumination has earned for it. But the latter is making its way in public favor, and it has certain peculiarities which make it an interesting subject for study.

A closed-coil armature is one in which the entire conductor on the armature is wound continuously around an iron core. Such an armature in the form of a Gramme ring is sketched in figure 16. The Gramme

ring is the form of armature employed almost without exception in closed-coil dynamos intended for series arc lighting. The figure shows the winding divided into eight sections with four turns of wire in each section. Such armatures for arc lighting have in reality a great many more sections and turns of wire, the latter running as high in the largest machines as 8,000 to 10,000 turns. It will be observed that a connecting wire is led from the junction of every two adjacent sections to the proper segment of the commutator. The commutator segments are insulated from one another either by mica or by mica and an air space combined.

The lines of magnetic force enter the armature from the north pole of the field magnet and divide and traverse the iron above and below across to the south pole. When, therefore, the armature is rotated in the direction of the arrow, an electro-motive force is generated in the wire or both halves of the ring, and its direction is upward on both sides toward the top of the ring. Consequently if two brushes are made to bear on the commutator, as shown in the figure, the upper one will be the positive brush and the lower one the negative. The two halves of the ring are therefore in parallel with each other. If the machine is symmetrical both halves of the armature generate the same electro-motive force, and if the brushes are placed at the points of highest and lowest potential, that is, near the top and bottom of the ring, respectively, all of the electro-motive force generated will be direct and will contribute to the electric pressure which causes the flow of current. The line C C joining the points of contact of the brushes and commutator segments is called the diameter of commutation. If the brushes have the greatest difference of potential between them on the line C C, then when they are rocked forward so as to shift the diameter of communication to C′ C′, the electro-motive force generated in the coils lying between the lines C C and C′ C′ is opposite to the direction in which the current is flowing. Hence, the electro-motive force in these coils on both sides of the armature is a counter electro-motive force, and must be subtracted from the rest of the electro-motive force generated in the ring to get the effective electro-motive force driving the current. It is evident, therefore, that regulation to constancy of current, with varying loads, may be accomplished under the proper accessory conditions by shifting the brushes forward or backward round the commutator cylinder. When the load diminishes the brushes must be shifted forward to cut down the electro-motive force and to keep the current constant; when the load increases again, by increasing the number of lamps in circuit, rocking the brushes backward transfers counter electro-motive force to the direct electro-motive force side of the armature, and so raises the total electro-motive force to the amount necessary to restore the current to its normal value.

THE NEUTRAL PLANE AND SUPPRESSION OF SPARKING.

By the neutral plane is meant the plane passing through the axis of the armature, and so situated with reference to the poles of the field magnet that when a coil of the revolving armature is carried across it the electro-motive power generated changes direction. This plane intersects the armature in a straight line, but it may broaden out more or less into a surface of small dimensions.

The plane of commutation passing through the points of contact of the brushes with the commutator is also the plane containing the poles of the armature considered as an electro-magnets. This plane shifts with the brushes, since the poles of the armature are the points at which the current enters and leaves the armature; and these are necessarily the points or surfaces of contact of the brushes with the commutator, assuming that the connections from the armature to the commutator run directly out parallel to the shaft. The question arises, Does the neutral plane shift when the brushes are shifted forward or backward? If we were to make answer from the assumption that the resultant of two impressed magnetizations or magneto-motive forces may be obtained in the same manner as the resultant of two forces by means of a triangle of forces, we should probably conclude that the neutral plane rotates forward with a forward movement of the brushes; but experiment along several different lines shows that this conclusion is an error.[1] As nearly as can be determined, the points of highest and lowest potential on the commutator, or the points where the electro-motive force changes sign, remain practically fixed with respect to the poles of the field magnet, whatever may be the position of the brushes. If we were to apply to the solution of this problem the principles derived from constant potential machines, we should be forced to the conclusion that to maintain sparkless commutation at the brushes the lead of the brushes beyond the neutral plane should be constant, since the current remains constant; and, therefore, that any attempt to govern for constant current by rocking the brushes must be attended by destructive sparking, unless at the same time the field is greatly modified. But these conclusions are also erroneous.

If we assume that the armature is well balanced electrically and magnetically and that the brushes have a proper bearing in contact with a smooth commutator, the conditions required to commutate the current without sparking are known to be as follows: With a two-pole dynamo the current is divided through the armature, one half going from brush to brush on one side and the other half through the other side. Hence when an armature coil is carried past the brush it is transferred from the one circuit through the armature to the other, and at the same time the current through it reverses its direction. This constitutes the act of commutation. But the sudden decay

[1] Journal Franklin Institute, p. 140, February, 1894.

of a current through a coil in one direction and its growth to an equal value in the other gives rise to an electro-motive force of self-induction opposing the change. This electro-motive force will prolong the flow of the current on one side of the brush and will oppose its rise on the other side. Hence if the coil is short-circuited by the brush lapping over the two consecutive commutator segments to which its ends are connected, even when the coil passes the neutral plane of the dynamo, the electro-motive force of self-induction produces a local current through the coil, and when the one end of the coil slips past the brush and becomes a part of the other half of the divided circuit, the current, which should reverse through it, meets the opposing current and breaks over the gap to the brush with a spark. The commutation must not take place, therefore, at the neutral plane, but in advance of it, and in a field where the induced electro-motive force in the coil shall be just sufficient to offset the self-induction, and, in addition, shall reverse the current in the coil while it is passing the brush or pair of brushes and cause it to grow to the normal value at the instant when one end of it passes out from under the brush. The induction from the field must be sufficient to bring the one current to zero and to set an opposite one of equal value flowing in the coil during the time it is under the brush. Then the commutation will be sparkless.

Now, if the current is kept constant in strength, the field induction required to accomplish the results described is approximately the same, whether the coil is short-circuited at one angle or another in advance of the neutral plane. It would appear at first thought that, unless the induction in every part of the field from the neutral plane to a point nearly 90° in advance of it is substantially uniform, destructive sparking must result when the brushes are shifted far forward to vary the electric pressure to suit the requirements of the circuit, for if the induction is in excess of the requirements to accomplish the result described in the commuted coil, then a current will circulate through it during the short-circuit, and the rupture of this on leaving the brush will cause sparking. Considerations of this kind have led some writers to say that sparkless commutation for any position of the brushes can be accomplished only when the induction in that part of the field traversed by the brushes during regulation is made perfectly uniform. But, while a uniform field accomplishes the result, no such uniformity is required; the same result may be secured in other ways.

For practically sparkless commutation it is not necessary that the induction near but under the brush shall be constant. Aside from the special devices to be described later, the effective means by which, with constant current, the brushes can be set in any plane around the commutator cylinder is the reactive effect of the armature. This fact is brought out by plotting the integrated potential differences between the upper or positive brush and a third exploring one as ordinates to

a horizontal line. This has been done in figure 17, in which a decided flattening of the curve will be found at 180°, the position of the negative brush. The same flattening may be seen at 0°. All curves plotted with data obtained under different loads show the same diminution or stay of the inductive process near the poles of the armature. The armature at these points paralyzes the field. As the poles of the armature move around during regulation they sweep away the lines of force of the field, and only enough remain to produce an electro-motive force competent to offset the electro-motive force of self-induction and, in addition, cause the newly directed current to grow to its normal value as the coil passes out from under the brush. In fact this reactive power of the armature may be utilized to effect approximate regulation for constant current without brush shifting. But for this purpose the load can not be a maximum. The poles of the armature must be far enough forward to produce increase of magnetic leakage. The

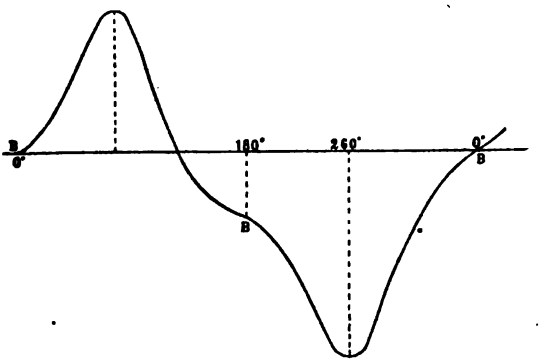


FIG. 17.

characteristic of the machine, when its normal current is reached, will then approach a vertical line, the ideal characteristic of an automatic constant-current dynamo.

The condition requisite for sparkless commutation of a constant-current machine is therefore this: The self-induction of the short-circuited coils must nearly, but not quite, balance the induction due to the field in all positions of the brushes. With these preliminary considerations relating to the principles of closed-coil constant-current dynamos for arc lighting, we may proceed to the description of the several machines of this class which were exhibited at the Columbian Exposition.

THE WOOD DYNAMO.

The Wood constant-current arc dynamo possesses several features of superiority, both in electrical design and mechanical details of construction. It has been well tested practically, and is in use in numerous stations throughout the country. Figure 18 is a good view of an

eighty-light machine of this pattern, manufactured by the Fort Wayne Electric Company. The field is composed of a double magnetic circuit, with consequent poles between the field coils at the top and bottom. The vertical end plates constitute the yokes, and heavy curved pole pieces are bolted fast to the field cores at the consequent points of the magnetic circuit. Between these curved pole pieces revolves the Gramme ring armature, which has a core of soft-iron wire mounted on the shaft by means of a gun-metal spider. There are four joints in each of the two magnetic circuits where the field cores are bolted to the end plates and to the pole pieces. There is little objection to such joints in a high potential machine of this class, because their effect is insignificant in comparison with the large interspace between

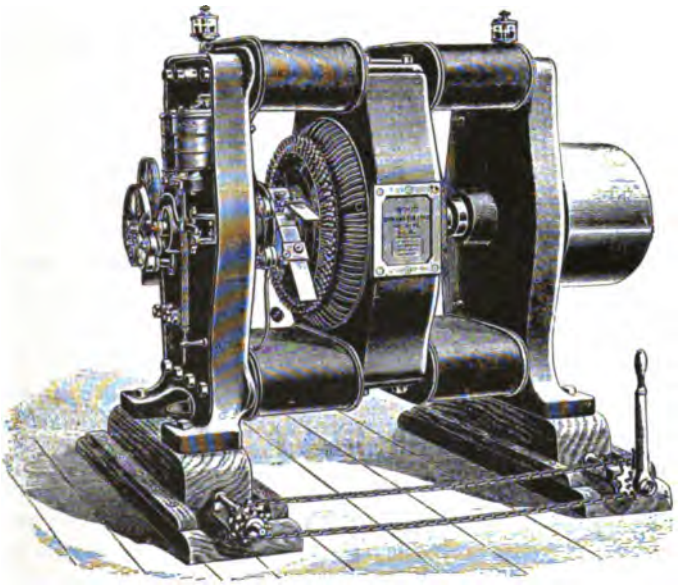


FIG. 18.

the pole pieces and the iron core of the armature. A wide air gap is necessary in such high potential machines to make room for the large amount of copper wire which must be wound on the armature for the purpose of obtaining the requisite electro-motive force. The Wood machines are rotated with a speed of about 850 revolutions per minute, and they are well balanced dynamically, so as to rotate without sensible vibration. They are fitted with a new expansion bearing, which prevents the overheating and sticking of the journal. These bearings are constructed so as to prevent the accumulation of oil on the field magnet, the waste, if any, running to a drip cup on each end of the dynamo. The machine is placed on a sliding base, by means of which the belt may be tightened or loosened while the machine is in operation.

The system of regulation adopted in this machine combines the shift-

ing of the brushes with a change in their spread or overlap. It employs two pairs of brushes, and varies the angular distance between the members of each pair when the brushes are moved. The field is not modified in the regulation, either by cutting out turns of wire or by diverting a part of the current through a by-path or shunt. The movement of the brushes is effected mechanically in response to any change in the main current by means of the automatic regulator mounted on the front end of the machine. The current of the machine passes through the solenoids at the top of the regulator, the cores and armature of which operate a lever, which serves by means of friction wheels to set in operation a train of spur wheels connected with toothed arcs on the brush holders. Both members of each brush are shifted in the same direction, but one moves more rapidly than the other. The spread of each pair of brushes is lessened as they rock forward toward the polar centers.

The operation of the regulator is as follows: If the current increases above its normal value the cores of the controller magnet are drawn higher up into the solenoids, and the friction wheels set in motion the gear train so as to rock the brushes forward, and at the same time to decrease the distance between the members of each pair. This causes a diminution in the electro-motive force of the machine till the current returns to its normal value. To bring the current from a smaller value up to its normal, the cores of the controller magnet descend, and so bring into action another set of friction wheels, by means of which the motion of the gear train is reversed, and the brushes are rocked backward. As soon as the normal current has been reached in either direction the friction wheels and motor mechanism are left out of service.

The change in overlap of the brushes in regulation is due to the fact that the field of force is denser near the center of the pole faces than elsewhere. This is perhaps generally true, unless the poles are reduced or recessed at the back to increase the magnetic reluctance in that region. Attention is directed to this point in some machines described later on. It is not practicable to reduce the pole thickness at the middle on the Wood dynamo, except by increasing the clearance at that point. The induction in that region is consequently too large to be counteracted by the poles of the armature, especially as the proportion of copper to iron in the armature of this machine is large. Hence resort is had to the lessening of the overlap of the brushes as they are rocked forward. In the first place this shortens the time allowed for the reversal of the current The curtailed time interval increases the self-induction of each wire, because it increases the rate of change of the current in the coil undergoing commutation, but this increase is at least counterbalanced by the diminution in the number of turns of the wire short-circuited by the brush. Hence, the total induction during commutation remains not

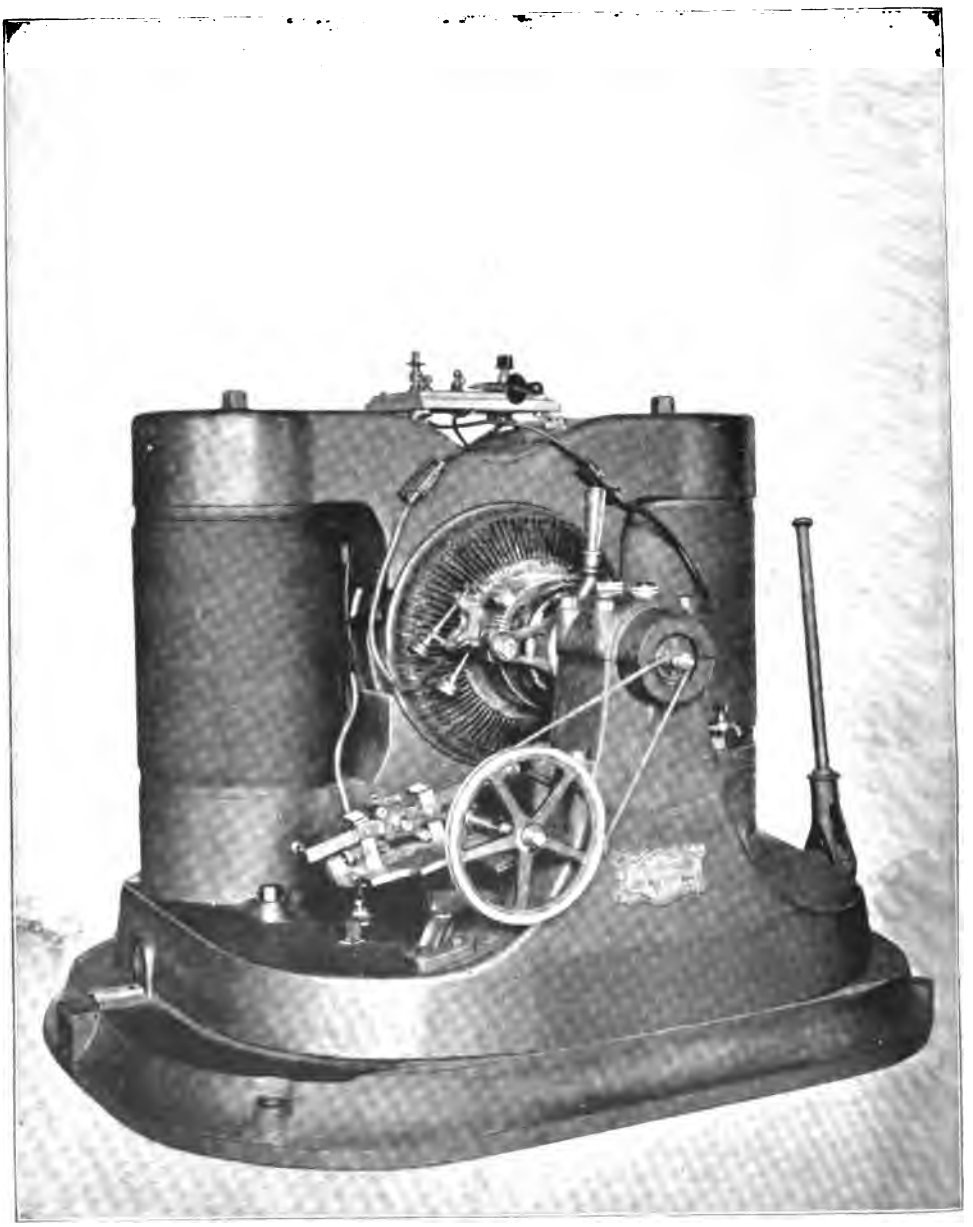


FIG. 19.

far from constant. When the brushes shift forward into a denser field the decrease in the overlap decreases the number of turns of wire included between each pair of brushes and so cuts down the total field induction in those coils during commutation to the amount required to suppress sparking. This method of regulation allows the largest Wood dynamo to run with nearly sparkless commutation from short circuit to 120 arc lamps, requiring at least 6,000 volts electric pressure. While this enormous potential difference exists between the opposite sides of the commutator, yet with as many as 160 commutator segments, there is only about 75 volts difference of potential between any two adjacent ones. No difficulty appears to be encountered in securing the proper insulation and preventing sparking. A channel is cut around the commutator next to the armature to prevent long sparks leaping into the armature when the circuit is suddenly opened, or a great change occurs in its resistance, and before the regulator can reset the brushes.

In the Wood machine each commutator bar is connected to the coils by a special clamp which can readily be removed. If a single coil burns out it can be disconnected and bridged over at the clamps till it is convenient to rewind the damaged section. The machine will show only a slightly diminished electro-motive force.

These machines are doing satisfactory service, and they compose some of the largest municipal plants in the United States.

THE STANDARD DYNAMO.

Somewhat analogous to the Wood dynamo is the arc-light dynamo of the Standard Electric Company. Its field magnet, figure 19, is of the double magnetic circuit, consequent pole variety, and of the form known as the Manchester type. It differs from the Wood in having the armature axis at right angles to the plane of its field magnets instead of in that plane. The result is a number of differences in point of detail. There are only two field-magnet cores and two joints in the magnetic circuit. The pole pieces are greatly reduced at the back, both top and bottom. This reduction is analogous to the round opening in the center of the pole face of the Thomson-Houston machine. It has the effect of spreading out the lines of force rather more uniformly over that portion of the pole faces along which the brushes travel during regulation, and hence contributes to make the points of commutation for nonsparking and constant current identical. While this is a commendable detail in construction, the author has ascertained by many experiments that dynamo machines operate satisfactorily in practice, both as regards constancy of current and nonsparking, even though considerable variation in the induction about the pole faces exists before it is modified by the presence of the armature pole. In the Standard machine the movement of the brushes

from no load to full load is from 30° to 40°. Only one pair of brushes is employed. They overlap about three segments of the commutator, and run quite sparklessly with any load from short circuit to the full complement of lamps.

The insulation between the commutator segments, or that part of them on which the brushes bear, is an air space, and the brushes on the larger machines are carbon. The interior of the commutator is open so as to allow the copper or carbon dust to blow out. The armature is a Gramme ring, and the core is made up of thin mild-steel rings insulated from one another, and mounted on a bronze spider keyed to the shaft.

The regulation is effected solely by moving the brushes. This is accomplished by using as the device responsive to the current to be regulated a small bar of iron mounted between the pole tips, as shown in the engraving. Any change in the field magnetism, consequent upon a change of current, gives a small motion to this magnetic vane, which in turn brings into action the motor mechanism driven by a belt from the shaft. Two pawls act upon a bar ratchet, one causing it to advance and the other to recede. When it recedes the brushes rock forward and conversely. The engagement of one or the other of these pawls is controlled by the magnetic vane responsive to the field and armature magnetism. When the current has its normal value neither pawl is engaged with the ratchet. It will be evident that this regulator moves the brushes to the position in which the current assumes its normal value, and leaves them there, till some change occurs in the circuit which requires it to resume its controlling function.

The journals are self-oiling, two rings conveying the oil from the reservoir under the journal to the shaft above. The bearings are of the universal ball construction, so that the armature has at all times proper alignment. The lower yoke of the machine is separated from the base by nonmagnetic distance pieces 1.5 inches thick, for the purpose of reducing magnetic leakage through the base. Such leakage has the effect of making the induction unsymmetrical, and often causes sparking at the lower brush.

It is of interest to compare two machines of the same capacity but of different make and differing widely in core-section and turns of wire on the armature and field. The data relating to the two are given in the following table:

Machine.	Total volts.	Revolutions per minute.	Segments in commutator.	Turns per segment.	Total turns in armature.	Cross sections of iron.	Lines per square inch.	Total turns on field.
						Sq. in.		
A	2,900	1,000	132	36	4,752	26.5	70,800	4,500
B	2,800	875	120	72	8,640	14	79,000	5,984

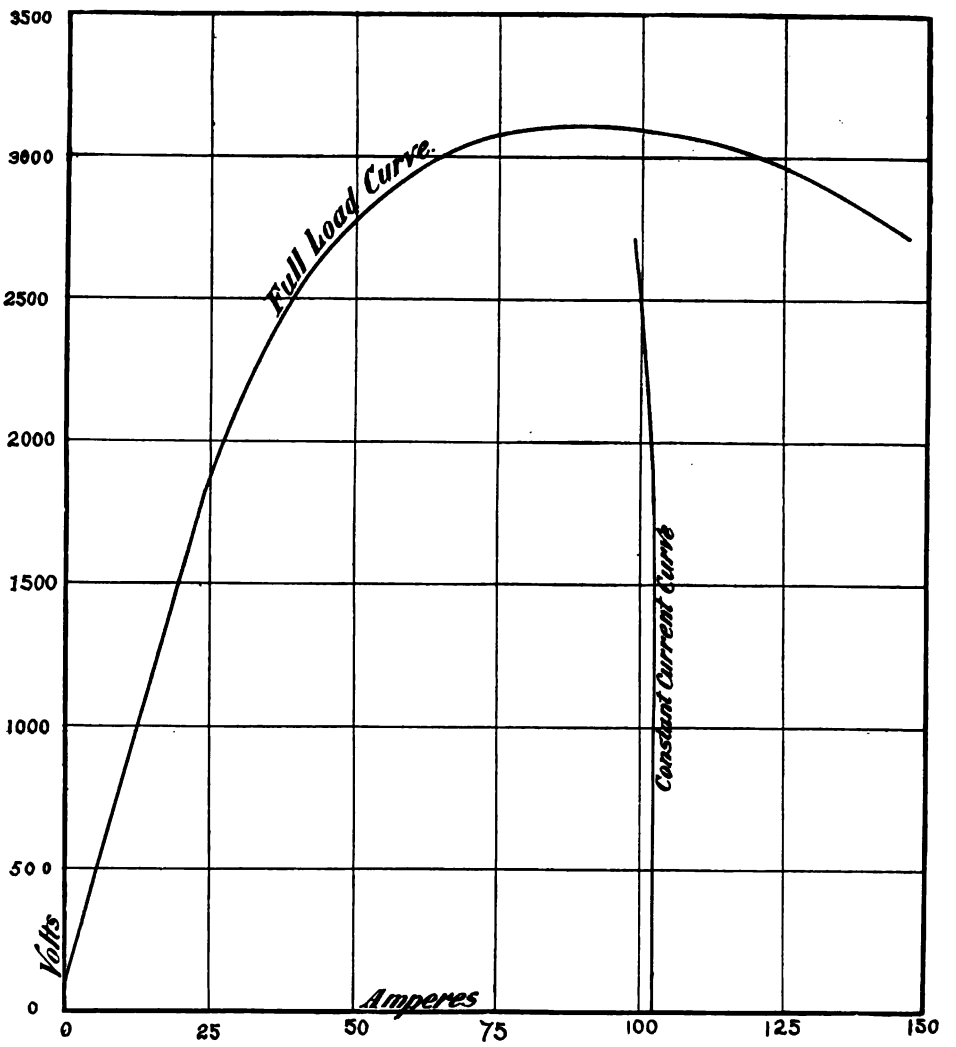

3500
3000
2500
2000
1500
1000
500
0
Volts
Full Load Curve.
Constant Current Curve
Amperes
0
25
50
75
100
125
150

FIG. 20.

Mau

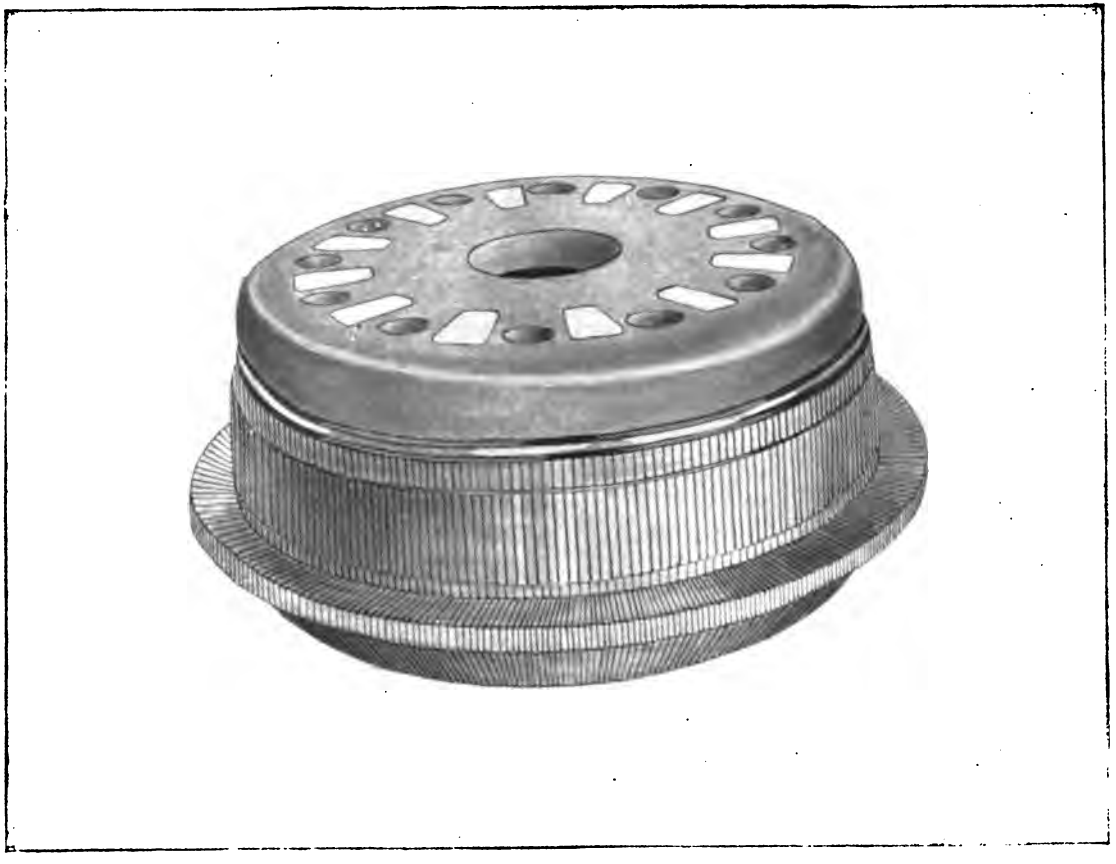


FIG. 21.

The A machine is an older pattern of a fifty-light standard dynamo. The B machine is the 1889 pattern made by another company, and should not be compared with the more recent one of another manufacture, except to show the great diversity of practice and design which has prevailed.

The maximum number of lines of force running through the armature of the A machine is 3,650,000; of the B machine, 2,213,000. The two machines were designed for the same current of about 9.6 amperes. The ratio of ampere turns on the armatures of the two is nearly inversely as the cross section of their iron cores, that on the B armature being 82 per cent greater than on A. The field ampere turns on the A machine is 42,200; on the B machine, 57,446, both at 9.6 amperes. The excess of field ampere turns over armature ampere turns on the A machine is 19,391; on the B machine, 15,974. The most notable difference in the two machines from an electrical point of view is the large amount of iron in the armature of the A machine compared with that of the B. The increase of iron reduces armature turns and cost. It is also favorable to regulation because of the increased domination of the armature magnetism.

The upper curve of figure 20 is the external characteristic of the fifty-light standard machine, with the brushes fixed at the full-load point. The vertical curve is the characteristic taken with the brushes set each time for least sparking. The amperes show only a slight increase from full load to no load. In other words, the current remains very nearly constant, while the voltage falls to the requirements of a diminishing load.

The machines of this company are made in sizes of from ten to one hundred lamps capacity, each lamp requiring 450 watts, or nominally 2,000 candlepower. With an allowance of 10 per cent overload, a 100-light machine must have a capacity of about 50 kilowatts, or 67 horsepower. With a dynamo of best efficiency for arc lighting, this would require the application of fully 75 horsepower to the pulley at full load.

The induction in the cast-iron yokes of the standard machine is 48,000 lines to the square inch; in the wrought-iron cores, 80,000 lines; in the air space, 30,000, and in the armature core about 88,000.

Following are some of the data for an 80-light machine: Number of armature sections, 144; turns per section, 42; total number of turns, 6,048; layers of wire, 6; revolutions per minute, 800; square inches of iron in armature core, 43; total cross section of armature core, 86 square inches; length of air gap for wire, insulation, and clearance, 1.6 inches; resistance of armature, 14.1 ohms; resistance of fields, 8.5 ohms; number of turns on fields, 3,264 each. Figure 21 is the commutator of a standard 100-light machine.

THE EXCELSIOR DYNAMO.

This machine, designed by Mr. William Hochhausen, of the Excelsior Electric Company, represents quite a departure from the other arc-light dynamos described up to this point. The engraving, figure 22, shows the machine ready to be belted to the engine. Its field magnet consists of a single magnetic circuit, with the two cores united by a heavy cast-iron yoke, containing the long bearing of the shaft. The armature is an overhung Gramme ring, and it can be entirely exposed because of the unusual construction of the pole pieces. They are deeply channeled and hinged along a middle section. When they are

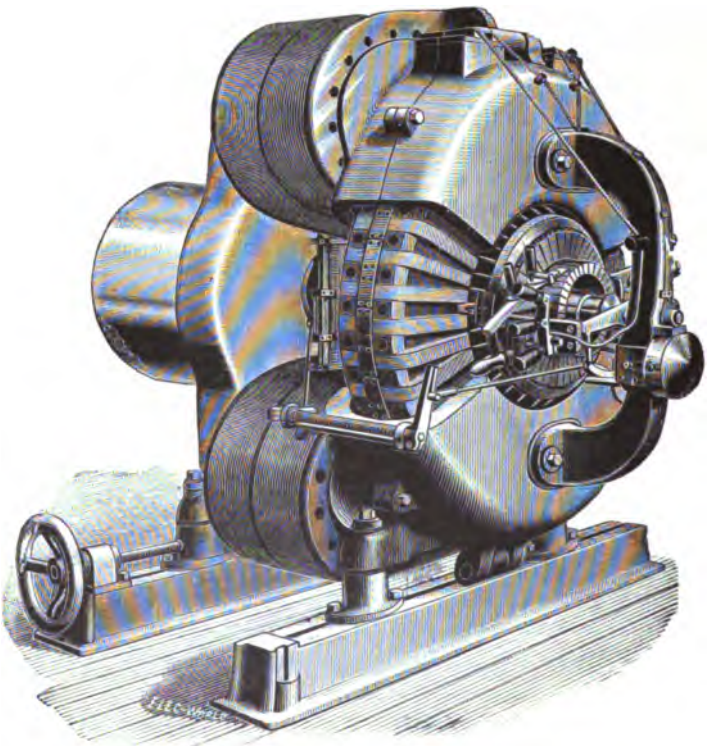


FIG. 22.

thrown back, as represented in figure 23, the armature can be thoroughly examined or easily removed.

The armature core is built up of iron wire, insulated by paper, and wound on a cast-iron frame having a T section, which divides the core into two parts. The arms of the spider, which holds the frame, are insulated from both core and frame. The coils are rectangular in shape and are separated on the periphery by wooden wedges secured to the cast-iron frame. The insulation of the armature is extremely good. The ratio of copper to iron is large. This is usually the case where iron wire is employed for the core.

The regulation is effected by a combination of rocking the brushes and changing the ampere turns on the field. When lamps are cut out, the brushes are automatically rocked forward and field windings are cut out by a sliding contact maker. For this purpose one-half of the field is wound in twenty sections and their terminals are brought out to

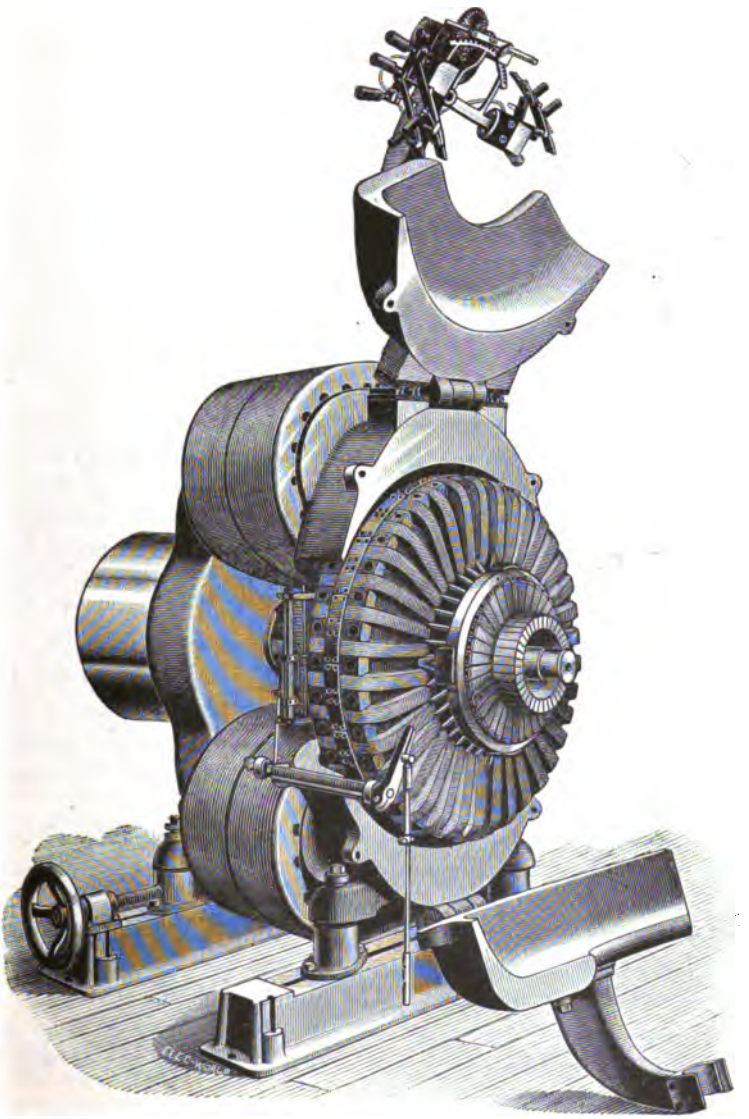


FIG. 23.

the field sliding switch. No change is made in the spread of the brushes. The electro-motive force of the machine is therefore cut down by the double device of forward brush shifting and of cutting down the excitation of the field. It has the advantage of reducing the resistance of the fields and the internal heat loss of the dynamo on small loads.

The regulator itself consists of a controller magnet operated by the main current to be governed and an electric-motor mechanism inclosed in the small hub, shown in figure 21. This electric motor utilizes the stray field through two cast-iron arms connected to the pole pieces, but insulated from them by a rubber distance piece. Whenever a current is sent through this motor it shifts the rocker arm carrying the brushes, and at the same time moves the sliding field switch by means of a system of levers, as shown. The controller magnet serves by means of its armature to operate two contact points. Both of these are closed when the armature is in its normal position with normal current, and then no current flows through the motor. When the current is above its normal one of these contacts is closed and a part of the main current flows in one direction through the motor; when the main current falls below its normal value the other contact only is closed, and a reverse current causes the motor armature to rotate in the opposite direction. Hence, under the one set of conditions the brushes are shifted in one direction and under the opposite set in the other direction.

The density of the field is doubtless greater near the center of the pole faces than elsewhere. Consequently sparking would follow the forward shifting of the brushes into this denser field unless at the same time the field excitation were cut down in the manner indicated. In other words, the inequality of the induction along the polar faces is too great to be equalized by the magnetic reaction of the armature, which contains only a relatively small proportion of iron. The double device employed gives, however, very satisfactory regulation.

The machine for 100 lamps of 450 watts each, made by the Excelsior Company, has an armature 30 inches in diameter and wound in only thirty-six sections. The speed is 700 revolutions per minute and the total weight 5,500 pounds. About 1,500 pounds of this consist of copper wire on the field and armature.

The most recent machines of this pattern will generate as high as 10,000 volts. Unusual precautions are then taken to insulate the various parts. To avoid the ill effects of static charges from the belt, the armature is insulated with mica from the spider, the bearings are insulated from the body of the dynamo, and the latter from the iron skids on which it is mounted. The company claims that these dynamos can generate and safely use higher electric pressure than any of the underground cables now in use in the United States will work under without danger of breakdown.

The following are the data relating to this 200-arc-light machine (10,000 volts) made by the Excelsior Company: Current, 10 amperes; speed, 625 revolutions per minute; number of coils on armature, 48; size of wire, No. 14 B. and S. G.; number of turns in each coil, 220; number of commutator segments, 48; external diameter of ring, 33

inches; internal diameter, 20 inches; cross section of ring, 6.5 by 6.5 inches; size of wire on field magnet, No. 8 B. and S. G.; weight of magnet wire, 1,600 pounds; weight of machine complete, 16,000 pounds.

At least 165 lamps can be switched on and off this machine at once without causing the slightest interruption in its operation.

THE WESTERN ELECTRIC DYNAMO.

The arc-light dynamo until recently built by the Western Electric Company is the only American machine employing a drum winding on the armature. The armature is so put together mechanically in winding that the coils, or at least a limited number of turns of a coil, can be removed in case of a burn out and can be replaced without entire rewinding.

The field has consequent poles and the pole pieces are recessed or cut through in the middle of the polar face, leaving only a thin shell of iron at those points for the purpose of producing uniform induction about the pole face in both directions from the middle, so as to be able to govern by automatic rocking of the brushes, as heretofore explained, and so that the rotation of the armature may be in either direction.

The commutator is composed of a limited number of sections, about eighteen in the larger machines, with air insulation or air gaps between the segments, and of excellent mechanical construction. Carbon brushes or collecting surfaces, carried on brass or copper springs, are employed. These give good satisfaction.

Regulation with a varying load is accomplished by automatic movement of the brushes. The responsive or actuating device is an electromagnet in the main circuit. The motor mechanism is driven by a belt from the armature shaft. It is in action only when occasion arises to shift the brushes.

These machines are made in two forms—high-tension machines for 9.6 amperes and lamps of 50 volts each, and low tension, of 18 amperes and twenty-five-volt lamps. The latter are often called short-arc lamps. Ten of the high-tension dynamos made by this company were in use in lighting the exposition grounds, while several others of different capacity were exhibited in the electricity building.

The most recent type of constant-current dynamo built by this company differs radically from those heretofore described. It is designed to meet the dynamo specifications of the public lighting commission of the city of Detroit. These specifications were unusually exacting, but the dynamo built to meet them is declared by experts to be even in excess of the requirements.

The magnetic field of this machine has four salient poles, alternately north and south, and connected in series with the armature. The armature is a Gramme ring with several coils connected in a series group system, so that only one pair of brushes is required 90° apart.

The commutator is large, as shown in figure 24, and has numerous removable segments with air insulation, carbon brushes, and fireproof insulation.

At a speed of 500 revolutions per minute this dynamo will maintain a current of 9.6 amperes through 100 fifty-volt lamps on a circuit 20 miles in length. While so operating it may be short-circuited or the current may be opened without injury to the machine. Regulation is effected by the automatic brush-shifting device of this company.

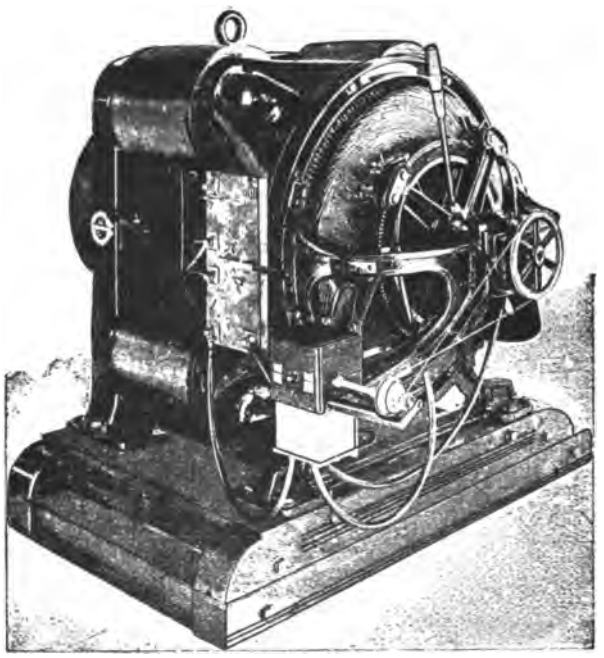


FIG. 24.

The bearings of the armature shaft are self-oiling and self-aligning and of ample dimensions. The machine is very compact and occupies but small floor space. The pole pieces are recessed at the back to secure an approximately uniform distribution of induction along their faces. Eighteen of these machines will be installed in the Detroit city plant for street lighting.

REPORT ON RUBBER COVERED INSULATED WIRES FOR ELECTRIC-LIGHT WIRING.

By DUGALD C. JACKSON.

[Tables I and IV and the illustrations described in this article were not furnished.]

The demand of insulated wires to be used in buildings for the purpose of electric light has grown at a remarkable pace in the United States during the past half dozen years, and the methods of construction and materials used in the wiring have made equally remarkable advances. Consequently, but a limited portion of the numerous collections of wires designed for this purpose which were on exhibition at the World's Columbian Exposition were insulated with compounds which have been long known to the electrical trade, or have lived through a sufficient period of commercial service to determine their true commercial usefulness.

Other classes of wires which are included in the same group as those intended for wiring in buildings are generally put into service under conditions which enable a comparatively early judgment of their commercial value. This is partially due to the severe condition of their service, but largely to the fact that they are either continually under the eye of a patrolman or are subjected to frequent tests. For instance, the insulation of cables which are used in underground circuits is kept in very high condition by means of frequent tests and repairs. The records of tests and repairs upon such cables which have been in use for a few years serve as the best criterion of their commercial value.

In the case of common weather-proof line wire, which is intended for use overhead, fine insulating qualities are not sought. Fair insulating qualities in damp weather and great power of resisting abrasion and the rotting effects of the weather are required. The qualities of such wire are readily determined by its examination in positions overhead after it has been exposed to the weather for two or three years.

The judgment of wires which are intended for inside wiring is not so easily accomplished. The greater part of the electric-light wiring which is placed in buildings is covered by plaster. It is here subjected to some extent to the action of moisture and of various reagents contained in the plaster or sizing used in finishing the building. Wires of this class are also placed in chemical works, dyehouses, oil refineries, breweries, stables, and other establishments where they are continually

subjected to the attack of active reagents of various kinds. As a breakdown of "inside wiring," must always cause considerable and expensive repair when the wires are located under plaster, it is important that the insulating compounds have great power to resist the action of the chemicals that are likely to be met in service. An actual service of a decade without failure when under the severest commercial conditions is not too much to ask of a satifactory rubber insulation. It is thus easy to see that an examination of wires which have been in successful service in buildings for only one or two years, does not give a sufficient criterion upon which to base a judgment of the final value of the insulating compound. A number of the rubber coverings displayed at the exhibition had not even so long service to their credit, as their manufacture had been only lately begun.

In view of these conditions, the committee of the judges in the Department of Electricity on whom were lodged the important duties of examining all wires designed for use in electric lighting and transmission of power, determined to test the durability of the insulating qualities of wires insulated with rubber compounds. This action was particularly desirable, not only on account of our little knowledge of the durability and reliability of many of the wires which are now being pushed into prominence by their manufacturers, but also because assured safety from fires caused by electric wires demands that only the best of insulation be put in actual service.

The tests which are required by various associations of insurance underwriters to determine whether electric-light wires are sufficiently reliable to be used in buildings, vary as widely as the constitution of the associations. The rules of British and European underwriters do not vary as widely as the requirement made by the underwriters of the United States. In respect to the insulating materials which are used to cover electric-light wires for use in buildings, the British underwriters substantially agree that they shall consist of a substantial coating of india rubber of the highest quality, or other approved equally good materials that are impervious to moisture and are durable. They also commonly require that the insulating compound shall not soften at a temperature below 160° to 170° F. and shall not be easily inflammable. In the classic requirements of the Phoenix Fire Office it is demanded that the "outer coat of india rubber must be vulcanized (or treated in other specially approved manner), but the one next the metallic conductor must be pure." The object of this requirement is to give the insulating covering sufficient mechanical strength to withstand such abrasion as it is likely to receive, and at the same time to protect the copper wire from attack by such surplus sulphur as may have been left in the rubber during the vulcanizing process.

The pure rubber coat next the wire is supposed to absorb this sulphur. Some manufacturers in the United States make wires which

fulfill this requirement, which are seen in the so-called white core and red core wires; but the greater proportion of wires of this class under consideration, which are made in this country, are made with a homogeneous volcanized coating which is composed of a compound having india rubber as a base. To protect the metallic wire from the effect of sulphur or other chemicals in the coating it is generally tinned, but it is sometimes left without protection. When the manufacture of the covering is properly carried on, tinning or protection of the copper against free chemicals is, possibly, not a requisite of safety, but it is of sufficiently great importance as a protection against the effects of poor vulcanization to be insisted upon.

The rules which are issued by widely influential underwriters' associations in the United States do not, as a general rule, specify what qualities are demanded to make a satisfactory insulating cover for "inside wires." This is also true of the rules issued by the National Electric Light Association, which is an influential association composed of officers of local electric-lighting companies. Stringent rules are only enforced in the large cities, where a municipal electrical inspector holds office, and where the underwriters insist upon careful workmanship. In this case it is unfortunate that proper wiring is often dependent upon the personal firmness and integrity of the inspectors. That danger from fire exists in all poor wiring is no more to be gainsaid than that an additional danger to life is introduced by grade crossings over railroad express tracks. This danger from fire can be reduced to so small a minimum that it is practically negligible; so small can it be made, in fact, that electric lamps and motors, when supplied from a central or isolated plant, are without a peer as regards safety. The greatest elements which cause danger of fire due to "inside wiring" are poor workmanship and poor material. Among poor materials, poor insulating coverings for the wires are most likely to be used and are most difficult to detect, until the plant has been in service some time. Poor workmanship and poor insulation make a combination which is certain invitation to disaster, while good insulation will often conquer the effects of poor workmanship.

The conditions of "inside" electric wiring are such that it is of the greatest importance to the people of the United States that the commercial value of the various rubber-covered wires which are found upon the market be determined. Upon this ground the chairman of the executive committee of awards of the exposition entered into cordial cooperation with the judges, and arrangements for proper wire tests were effected. The tests carried out were as follows: (1) a simple "breakdown test" carried out under the directions of Prof. R. B. Owens; (2) a test of durability of insulations when under the action of various reagents and when subjected to a pressure of 6,500 volts, carried out under the direction of the writer; (3) a simple durability

test, in which the insulations were subjected to the action of various reagents, carried out by the writer with Professors M. O'Dea, R. B. Owens, and B. F. Thomas in consultation. While neither of the tests when taken alone gives a satisfactory index of the value or durability of an insulation, the combination of the results gives an excellent criterion of the action that may be expected of the insulations when they are placed in commercial service. Before the tests were made it was decided by the committee having the wire tests in charge to invite manufacturers who had wires on exhibition to submit selected samples for tests. For the purposes of the first and second tests, these were mostly selected from the exhibits. For the purpose of the third test, the following letter was addressed to the various exhibitors by Prof. M. O'Dea by direction of the committee. Of ten manufacturers who exhibited the class of wires to be placed under test, only three responded to the letter by furnishing samples. One of these did not fulfill the requirements in regard to thickness of insulation and absence of braiding. The committee proceeded with the tests, however, and caused additional samples to be bought in the open market. It was originally contemplated in the code for the test to procure market samples of each of the wires exhibited, but this was not found covenient in the case of three exhibitors, and their wires therefore do not enter the third test. One of the same exhibitors failed to furnish wires for the first and second series of tests. Since the completion of the official tests, the writer has made less extended tests upon the wires manufactured by two of these exhibitors and therefore includes the results in the summaries.

The wires entered for tests may be divided into two classes: First, those in which the conductor is covered by a seamless covering of rubber compound which is "spewed" on by means of a hydraulic press as the conductor passes through a die; second, those in which the conductor is covered by a strip of rubber compound which is wrapped around the conductor until the edges come together, when they form a welded seam. In each case the insulating compound is vulcanized after it is placed on the conductor. The copper conductor itself is in some cases a solid wire, and in others it consists of a strand of smaller wires. Outside of the rubber insulation some of the wires are served with a protecting braid or tape, but in others the insulating compound is naked.

I. BREAKDOWN TEST.

The object of this test was to determine the pressure required to actually "break down" or puncture the different insulating compounds when placed on wires to various thicknessess. For the purposes of the test the Westinghouse Electric Company kindly placed their great high pressure, variable ratio transformer at the service of the committee.

The arrangements for the test are diagrammatically shown in fig. 1. In this figure J is the variable ratio transformer, capable of giving any desired pressure up to the limit far beyond any required in these tests. C is a sheet-iron tank filled with water, in which the wires were individually immersed while subjected to the "breaking down" or "disruptive" pressure. W is a wire in test. V is a Thompson electrostatic voltmeter which was used for directly reading the pressure at the moment a specimen broke down. The "breaking-down" pressure was also independently determined by a Weston alternating-current voltmeter, V, in the primary circuit of the testing transformer. The reading of this voltmeter when multiplied by the known ratio of the transformer at the moment of breaking down gave an independent check upon the electrostatic voltmeter. The two determinations of pressure agreed to a very satisfactory degree, which showed the actual ratio of transformation to closely approximate its theoretical value. This being the case the "breakdown" pressures which are given in Table I are taken from the Weston voltmeter readings, because its readings were more readily taken and were more reliable, since the primary pressure remains fairly constant.

The results shown by this table are in agreement with the meager results of the few similar tests of which records are available. Russell gives a few "breakdown" tests of rubber-covered wires, in which the "breakdown" pressure per mil of covering varied from 185 volts to 233 volts. (Russell, Electric Cables, p. 122.)

It is of scientific interest to compare the "breaking-down" pressure per mil found by the tests with those found in experiments upon various materials by Mr. C. P. Steinmetz. (Note on Disruptive Discharge through Dielectrics, Trans. American Institute of Electrical Engineers, vol. 10, p. 85.) For this purpose the maximum number of volts per mil is averaged for each class of insulation and compared with Mr. Steinmetz's results in the accompanying table:

TABLE II.—*Breaking-down pressures for various materials.*

Material.	Volts per mil at "breakdown."	Material.	Volts per mil at "breakdown."
Kerite compound	348	Air	30
Okonite compound	263	Mica	5,000
Grimshaw compound	269	Vulcanized fiber	40
Paranite compound	342	Dry wood	330
Washburn & Moen compound	340	Paraffined paper	860
Simplex compound	376	Melted paraffine	206
India Rubber Co. compound	425	Copal varnish	76
		Vulcabeston	91
Average of rubber compounds	338	Asbestus paper	109

Table II shows that the rubber compounds which are placed on insulated wires have a very satisfactory disruptive resistance when compared with that of other insulating materials. The results of this

test, when compared with the results of the durability tests which follow, show in a striking manner the small value of simple "breakdown" tests as a criterion of the durability, reliability, and safety of rubber compounds designed for use at comparatively low pressures.

The tests bring out a point of interest in relation to the reliability of those wires having a seam in the rubber covering. Of this class the wires with okonite and paranite covering are the only examples. In regard to these, greater irregularity in the various samples is to be noted in the "breaking-down" pressure per mil than is seen in the seamless covers. The maximum difference between samples of paranite is greater than the average "breaking-down" pressure per mil, and the maximum difference between samples of okonite is over 60 per cent of its average "breaking-down" pressure per mil. The maximum difference between samples having seamless insulation in no case exceeds 40 per cent of the average "breaking-down" pressure per mil for the same material. This irregularity of samples covered with an insulation having a seam is made even more marked by taking it in terms of the maximum or minimum "breaking-down" pressure for the material. The resistance of an insulation to a disruptive or "breaking-down" discharge depends upon its homogeneity and the "breakdown" occurs at the point. The irregularity seen in samples of wire bearing a seam in the insulation may be ascribed to the imperfect weld of the rubber at certain points of the seam. These weak points give way when subjected to disruptive pressure. This is made more evident by the results of the second test, when the failure of okonite insulation sometimes occurred at the seam, which apparently opened up under the effect of the discharge.

In cases where the "break down" did not occur at the seam, the fault in any of the specimens always occurred as a small hole, which seemed to be blown or burned through the rubber. A very small defined hole of this kind, as it was found on a piece of market kerite wire, is shown in figure 2. In these tests alternating pressures were used. Alternating pressures may be more severe in their "breaking down" action upon insulating compounds than are continuous pressures, but no tests could be arranged to determine this point. In making the test the conditions surrounding the different samples were made as nearly uniform as possible. The length of wire immersed in each case was 36 inches.

II. SIXTY-FIVE-HUNDRED VOLT TEST.

In this test the resistance of various insulating compounds to the attack of reagents became a feature. The wire samples were similar to those used in the simple "break-down" test, but were of uniform size. The samples, in lengths of about 20 feet, were immersed in tubs containing the reagents, very much as would be done for testing insula-

tion resistance by ordinary methods. The tubs were four in number and contained the following aqueous solutions, respectively: hydrant water, saturated solution of sal ammoniac, lime water, and 20 per cent solution of sulphuric acid. During a considerable portion of their immersions the samples were subjected to an alternating pressure of 6,500 volts. While it was desirable to subject the wires continually during the submersion to the effect of the pressure, this was not possible on account of the conditions of the electrical supply. The periods during which the pressure was "on" were the same for all the samples, and the results are therefore entirely comparable. The immersion of each sample was continued until its insulation broke down completely, as shown, by the blowing of a fuse. The way in which the wires failed was quite similar to that seen in the higher pressure "break-down" test, but the effect of seams in the insulation was made more evident. The striking feature of this test is seen in the extremely rapid action of the three active reagents in searching out weak spots in the insulation. Not one of the samples immersed in hydrant water was broken by the pressure used, though the insulating coverings were not intended for use with pressure greater than 500 volts. In fact, two of the samples—kerite and paranite insulations—were continuously immersed in water for a period of three months, during which time 6,500 volts were applied for intervals with a view of breaking them down, but they were apparently without deterioration at the end of the test. Samples immersed in the active reagents failed in every case in less than twenty-four hours.

The following table gives the average results of the tests. The hours of life in the reagents is taken from the average results given by a number of test pieces 20 feet long cut from each sample of wire.

The life of the different samples of each insulation agreed fairly well except where it is otherwise noted in the table.

TABLE III.—*Results of 6,500 volts test.*

Trade name of insulation.	Manufacturer.	Hours' life when subjected to 6,500 volts pressure and in hydrant water.	Sal-ammoniac solution.	Lime water.	Dilute sulphuric acid.
Day's kerite	W. R. Brixey	Life of all wires in hydrant water extended beyond period of test.	12.5	20	Average 5.5, varying between 3 and 10.5
Okonite	The Okonite Co.		9	15	1.
Grimshaw white core	New York Insulated Wire Co.		6	0.3	Varying between 1 and 5.5.
Paranite	India Rubber and Insulated Wire Co.		4	3.5	2.
Paranite (braided)	do		10.5	17	Average 5.5, varying between 2.5 and 10.5.
United States solid core	United States Wire and Cable Co.		2.5	7.5	0.5

The rubber coverings were naked except where noted.

III. SIMPLE DURABILITY TESTS.

This test was designed to determine the comparative merits of various rubber insulating compounds when subjected to conditions usually met in low-pressure electric service. In actual service the reagents with which the wires come in contact are generally quite dilute and their action is frequently intermittent, as it depends upon the amount of moisture in the walls or material surrounding the wires. Under these conditions the life of wires may be great, while under conditions where the action of reagents is continuous and fairly severe the life of insulated wires is very short, as is shown by measurements of the insulation resistance of various isolated installations of wiring.

To fulfill the requirements of the test within a reasonable time, the committee having the matter in charge decided to immerse samples of all wires included in the test in tubs containing solutions of chemicals which are met by the wires when used in service. The solutions were made of considerable strength, so that the duration of the test need not exceed three months. In this way the conditions under which the wires are ordinarily placed in service are reproduced in exaggeration.

This does not give the years of life which may be expected of the different wires when used in electric lighting, but it gives a rigorous comparative determination of their durability. Their average years of life under various conditions can only be determined from actual use of the wires.

Since it was desirable to make the test a low-pressure one (that is, one in which the wires are subjected to no disruptive strain), the wires were not subjected to a continuously applied pressure, and insulation resistance was measured from time to time by means of a reflecting galvanometer and a silver chloride battery varying in number of cells from 250 down to 2 or 3. At the time the test was started it was found to be inconvenient to arrange for the use of a very sensitive galvanometer during the whole of the tests, and a galvanometer which gave good readings up to more than the equivalent of 100 megohms per mile was adopted. The wires of the class tested usually have an insulation resistance between 400 and 1,200 megohms per mile when new, and it is assumed that they have about reached their limit of usefulness when their insulation resistance has reached 100 megohms per mile. Table IV, which is inserted below, shows that some of the wires fell far below this limit in a remarkably short time, when they were subjected to the action of the chemicals. On the other hand, several of the wires withstood the action of the reagents so well that their insulation resistance was well above the limit at the end of the test. If the committee had fully appreciated the rapidity with which the insulation of some of the wires would depreciate, careful measurements of their initial insulation resistance would have been made to determine

the rate of their depreciation. The tests, as they stand, strikingly fulfill their object of determining the comparative durability of the insulating compounds.

No available place for the test was found upon the Fair grounds, and Chief J. P. Barrett offered to place a vault in the Chicago city hall at the service of the committee. This was accepted. The place holding the vats and wires was made inaccessible to all except the committee, and the tests were there carried on. In a compartment of the vault were placed five vats for the solutions. One of these was filled with hydrant water, one with a saturated solution of slacked lime, one with a 4 per cent solution of commercial ammonia, one with a 4 per cent solution of commercial sulphuric acid, and one with a mud solution made from slime collected from the bottom of a Chicago electric-light manhole. The latter contained a very considerable amount of potash, which seems to have been active in attacking the wires. After the test the solution smelled strongly of sulphureted hydrogen. In each vat were placed ten samples of wire 100 feet long, five of which were furnished for the tests directly by the manufacturers in response to the letter quoted earlier, and the others were purchased in open market. The two classes of samples are designated in the table as "shop" and "market" samples. Insulation measurements were made six times in the duration of the tests—when the wires were first immersed, after six days' immersion, after twenty-one days, after fifty days, after seventy days, after ninety-eight days—when the tests were discontinued and the samples removed from the vats, since the insulation of nearly all wires had fallen to a practically negligible magnitude. During the tests all the wires exhibited a steady decrease in their insulation resistance as shown by the galvanometer test after about one-half a minute electrification. The results for the sulphuric acid vat are practically nil as the acid destroyed successively two vats, and no satisfactory insulation records could be obtained. In the case of the ammonia vat there is no doubt that the percentage of ammonia was decreasd by evaporation, but the action on the wires in the vat was considerable, and sufficient ammonia remained in solution up to the end of the test to cause a very strong odor of free ammonia. The liquid in the vat at the end of the test also smelled strongly of sulphureted hydrogen. The only vat in which all the wires were not more or less severely attacked was that containing hydrant water. Chemical tests of the solutions before and after the period of immersion were made to confirm, if possible, the relative activity of the solutions as shown by the insulation tests. These showed that the organic matter absorbed by the solutions during the ninety-eight days and remaining in them were in the ratio of lime, 100; ammonia, 12; manhole mud, 3; hydrant water, 4. A certain amount of fermentation was shown to have occurred in the last three solutions by the formation of a very small

percentage of alcohol. It is impossible to decide what effect this fermentation may have had upon the rubber compounds, but since the insulations were not badly affected in the hydrant water it probably had little effect.

It will be seen from the data given in Table IV that only three of the types of wires fully complied with the code in regard to thickness of insulation and absence of braiding or taping. Two of the insulations (kerite and okonite), the manufacturers of which did so comply, are seen to be among the four which actually held a working insulation to the end of the test, although placed under a disadvantage in complying with the conditions. The market sample of kerite gave very bad results on account of the mechanical imperfections of the rubber, probably due to imperfect vulcanization. The shop sample of kerite wire was an admirable piece of insulated wire, and was only equaled in excellence by the magnificent samples furnished from the okonite company's shop. The market sample of okonite was not so fine in its enduring qualities, but it was an excellent piece of insulated wire. The market sample of Grimshaw wire made a good account of itself in the tests, but its mechanical qualities were not as good as is desirable. The external appearance of the samples of kerite, okonite, and Grimshaw insulations were not much affected by the period of immersion, but the appearance of the other samples suffered severely from the attacks of the reagents. The accompanying photographs show plainly the effect of the reagents and also the chemical imperfections of the samples. In each photograph is shown six lengths of wire, which represent the condition of one of the samples of wire before the test and after its immersion in different reagents. The lengths are marked with letters in the photographs to indicate the treatment they have received, and may be identified as follows: O, the wire before immersion; A, after 98 days' immersion in the lime vat; B, after 98 days' immersion in the dilute ammonia; C, after a short interval in dilute sulphuric acid; D, after 98 days' immersion in alkaline mud; E, after 98 days' immersion in hydrant water.

Each of the samples have received three twists in a length of 9 inches to open any imperfection in the insulation. These may be plainly seen in many of the photographs by the aid of a magnifying glass.

Upon consideration of the results of the tests that have been described it is not difficult to see that among the various wires tested kerite and okonite have shown the best results. Kerite wire has given the best results in durability and insulation as shown by the second and third series of tests. The poor mechanical condition of the market sample of kerite wire shows carelessness or irregularity in the manufacture which is a conspicuous evil, but may be easily detected by mechanical tests in any wire sample which has been out

of the factory for a few months. The insulation of okonite wires showed the most satisfactory mechanical qualities, and it may be placed second in durability as shown by the second and third series of tests. The mechanical qualities of Grimshaw wire are not so satisfactory, but its durability is fairly satisfactory as shown by the last two series of tests. Of all the other wires not one can be said to have proved itself a safe wire for general use for inside electric-light wiring. The wires manufactured by Washburn & Moen made a good record for themselves in the third test, but after an allowance is made for the extra thickness of their coverings and due allowance is made for the way in which the reagents attacked the coverings, as shown in the photographs, it is impossible to class them with the first three wires. In the unofficial supplementary tests mentioned earlier, okonite, paranite, United States, and Simplex wires were included. Those tests fully confirmed the results already given as relating to wires insulated with okonite, paranite, and United States compounds. They also showed that the durability of the Simplex caoutchouc wires can not be given a high place. It is a striking fact that the insulation of only one of the wires placed under test was unable to satisfactorily pass the heat test; that is, the test for softening at 170° F.

The tests show plainly that some fixed code of testing the insulation of wires intended for inside electric-light wiring should be adopted by the various influential associations of underwriters. The adopted test should be made upon samples bought in the market and should cover conditions similar to those met under service, but in an exaggerated degree, in order that a record may be made within a reasonable period. All wires should be required to pass the test before being approved by the underwriters. Supplementary tests of samples bought in the market might be required as often as every two years to determine whether the manufacturers of the insulation have held to a high standard of excellence and uniformity. The World's Fair tests indicate that a satisfactory determination of the durability of a wire for ordinary uses may be made by soaking it in limewater two weeks and carefully testing the insulation. The insulation testing may well be made with 500 or 1,000 volts pressure furnished from a dynamo, as such a pressure is likely to search out incipient faults, but great care must be taken to insure the complete insulation of the testing instruments and connecting wires when such high pressures are used. Soaking in water is not practically useful, as insulation which can not bear immersion in water is entirely unfit for the service here considered.

PRESENT STAGE OF ELECTRO-THERAPEUTICS.

By Wm. J. Herdman, Ph. B., M. D.,
Professor of nervous diseases and electro-therapeutics, University of Michigan.

That portion of the exhibit in the electrical department at the World's Fair which was made up of instruments and appliances designed to aid the physician, surgeon, and dentist was well represented both by home and foreign manufactures.

Electric energy has become indispensable to the busy and skillful professional man whose field of operation is the human body. He has found this energy directly serviceable in correcting and modifying diseased conditions, and the great variety of modes by which electricity manifests itself makes it applicable as a curative agent in a very wide range of pathological states. The direct application of electric energy to the body with the view of correcting disordered function alone deserves the name of electro-therapeutics. There are many abnormal conditions of the body, however, in the treatment of which electricity has become an indispensable accessory, employed as a motive power for the instruments made use of, or as a means of furnishing a cautery by its transformation into heat, or as a valuable aid to diagnosis by its transformation into light in the form of exploring lamps.

The electro-therapeutist has availed himself of every form of electric energy with which the physicist is familiar, and finds in their action upon the body effects peculiar to each. Constant currents, induced currents of whatever sort, and frictional or static electricity have each been called upon to do him service. This has given rise to an infinite variety of devices differing in design, according as one or another form of application is intended.

The value of electro-therapeutic instruments is in proportion to the knowledge and skill of the designer. This knowledge, in order to be sufficiently comprehensive and insure the best results, should extend into the fields of physics, physiology, and pathology, and a lack of knowledge in one or the other of these directions will account for much crude material designed for use in therapeutic work.

THE CONSTANT CURRENT.

The constant current is employed in therapeutics, with an electromotive force varying from 1 to 120 volts, according to the nature of

FIG. I.—Chloride of ammonium (Leclanché) batteries.

the work to be done. Resistances in the human body are extremely variable, and in order to meet this variability the source of electromotive force should also be arranged to vary at the convenience of the operator. The amount of current that may be safely borne by the

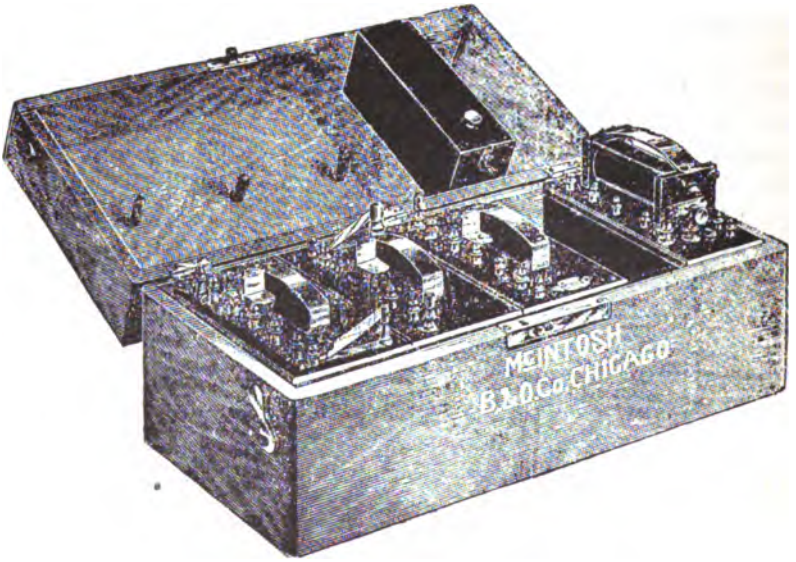


FIG. II.—Bichromate-of-potash battery.

tissues of the body without injury is confined within comparatively narrow limits; but as body resistances can not be kept constant, owing to certain variable conditions in living tissues, an external resistance possessing more or less constancy is usually required as a

part of the circuit, by means of which the operator can at will maintain the current at the desired amount. In the vast majority of instances, where the constant current is employed for therapeutical purposes, it does not exceed 20 milliamperes. In accurate work a reliable milliampere meter is an accessory, and although the majority of applications does not require the current beyond the amount mentioned, there are occasional demands for a much greater current. A good milliampere meter should, therefore, be made to register at least 500 milliamperes.

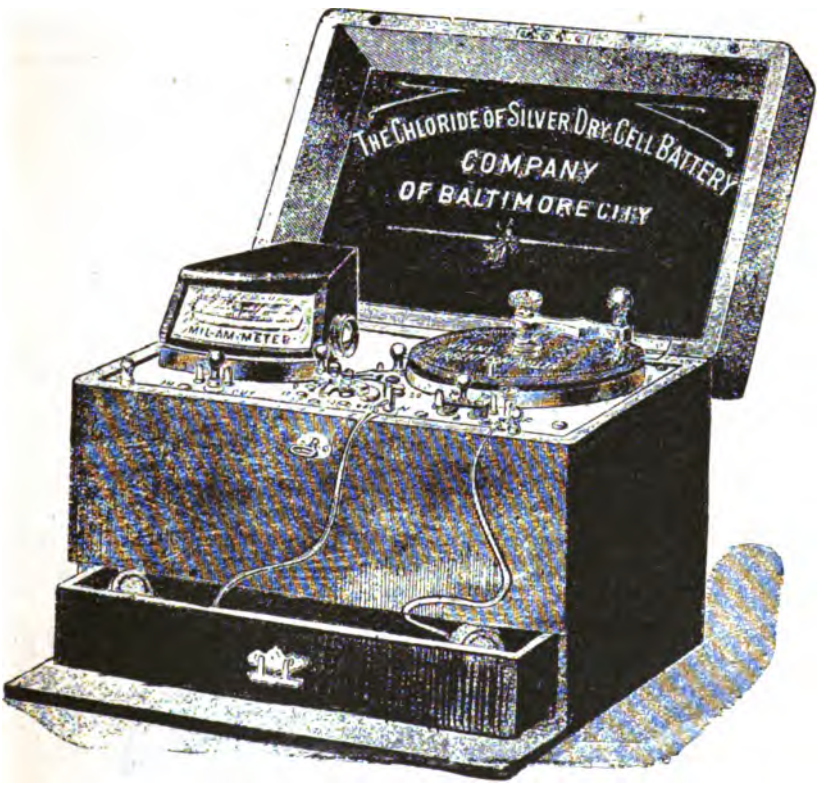


FIG. III.—Dry-cell portable battery.

The physician finds, therefore, in electro-therapeutic work with constant currents, that the essential requirements are a source of electric energy furnishing the required electro-motive force, a rheostat or controller for suitably modifying it, a reliable milliampere meter for measuring the currents, and suitable conducting cords and electrodes for applying it to the body. As to the source of electric energy, the physician and surgeon has been compelled until quite recently to depend upon some form of primary battery. While this remained the only source of electric energy, electro-therapeutics was greatly

retarded in its development because of the difficulty in maintaining the supply constant and uniform. Yet this stage of electro-therapeutics is marked by an exhibition of remarkable energy and ingenuity, as shown by the great variety of forms of primary batteries which have been offered to the profession. The need of this line developed a high grade of efficiency in this kind of apparatus. The chloride-of-ammonium cell, either fluid or dry, with zinc and carbon elements; the bichromate-of-potash cell, with the same elements, and the chloride-of-silver cell, have, by their universal acceptance, marked the highest stage of perfection of the primary battery for the physician's use.

FIG. IV.—Hydro-platinum rheostat.

Each of these three kinds of cells used for generating the constant currents have their special advantages, and one is adapted to some kinds of work better than others.

The ammonium chloride cell, for instance, of large size is most durable, but is inconvenient by reason of the number required to secure the intended voltage for satisfactory work in a physician's office. If made smaller its durability decreases proportionally. It is now being manufactured as an efficient cell in very small compass. All three forms mentioned are made up as portable batteries, with a little advantage in favor of the bichloride cell by reason of the fact that the physician can of himself renew its parts without being compelled to send it back to the manufacturer.

Illustrations here given represent some of the forms of these pri-

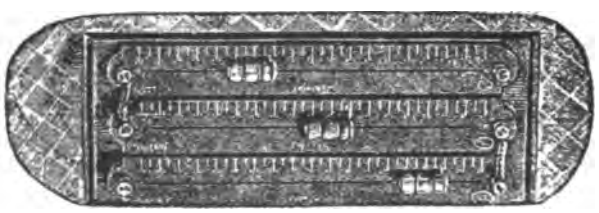


FIG. V.—Graphite rheostat.

mary batteries that were on exhibition at the World's Fair. They have stood the test of experience, and have proved most efficient for electro-therapeutic work.

It requires from 20 to 50 cells of this character to furnish the electromotive force necessary to overcome body resistance, and a battery composed of this number of cells must, in order to be adapted for its

work, be provided with a rheostat, or modifier, of the current and a milliamperemeter or instrument for measuring the current. The best of these batteries are so constructed. The rheostat and milliamperemeter may, however, be separate instruments, and it is often more convenient to have them separate.

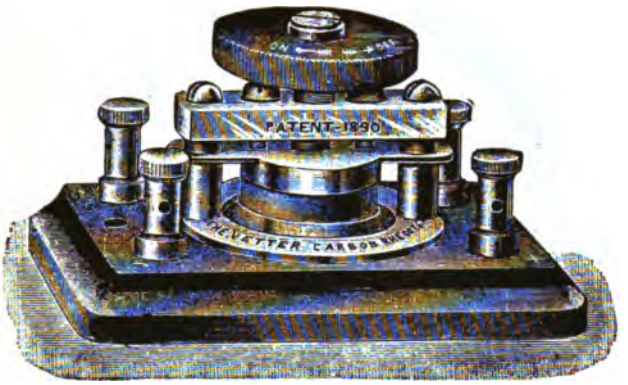


FIG. VI.—Graphite rheostat.

Three forms of rheostats have found more or less favor with those practicing electro-therapeutics—the fluid rheostat, in which the resistance is made up of water more or less pure; the graphite rheostat; and one composed of some form of metal which is a poor conductor of the electric current, German-silver wire being the material generally employed for this purpose. The last, while it is the most reliable and uniform in action, is at the same time the most expensive, and is seldom introduced, except into the most costly instruments. The other two, while they are capable of furnishing a wide range of resistance to the passage of the electric current, lack exactness and uniformity in action, and are therefore the source of much annoyance.

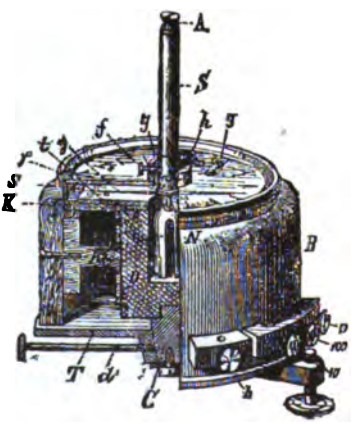


FIG. VII.—Milliamperemeter (galvanometer type).

The graphite rheostat, however, when properly constructed, is the next best of rheostats so far designed for therapeutic work. We have presented in the illustrations some of these forms which were on exhibition at the fair, and which are best adapted to the purpose indicated.

As regards the milliamperemeter for measuring the constant current, the physician has opportunity to make choice from several styles of

instruments. Some of these are constructed upon the galvanometer plan. By care in the selection of material of which they are made, and superiority in workmanship, some makers are able to furnish very excellent instruments of this class.

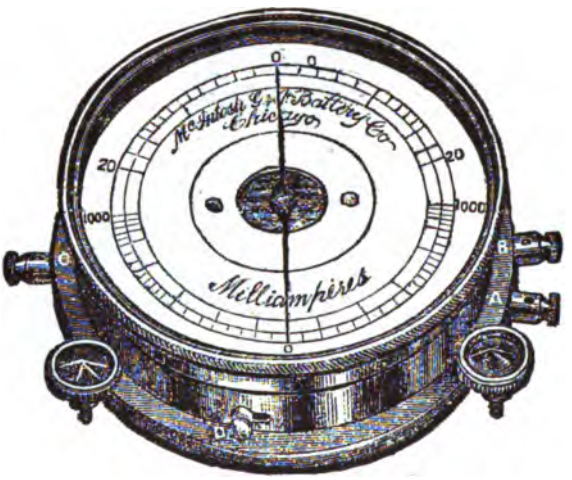


FIG. VIII.—Milliamperemeter (galvanometer type).

The chief objection to them is the fact that they are subject to disturbances by local magnetic influences. The indicator comes slowly to rest and the scale varies in uniformity and consequently in clearness. The other class of milliamperemeters is constructed of power-

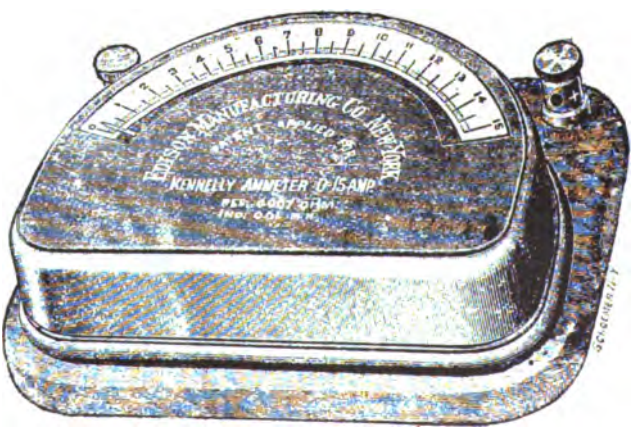


FIG. IX.—Milliamperemeter (magnet type).

ful permanent magnets with soft iron pole-pieces, between which a revolving armature is suspended, to which the indicating needle is attached. These instruments are furnished with a uniform scale, and are "dead beat," the needle coming to rest without vacillating. They

are free from the disturbing effects of masses of iron in their neighborhood or from local magnetic influences. In addition to this, they possess the advantage of working with almost equal facility and accuracy in an upright as well as a horizontal position, although it is true that both forms of instrument are in the most favorable position for

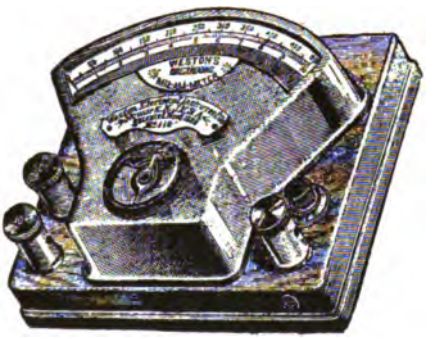


FIG. X.—Milliamperemeter (magnet type).

work when placed horizontally. Experience has shown the latter form to be the most durable; they are the least liable to get out of order. Numerous flaws are apt to occur in any one of the parts that are esssential to the application of constant currents in therapeutics, and he is the most skillful operator who is able to discover and correct these readily. The primary battery is by far the most frequent source

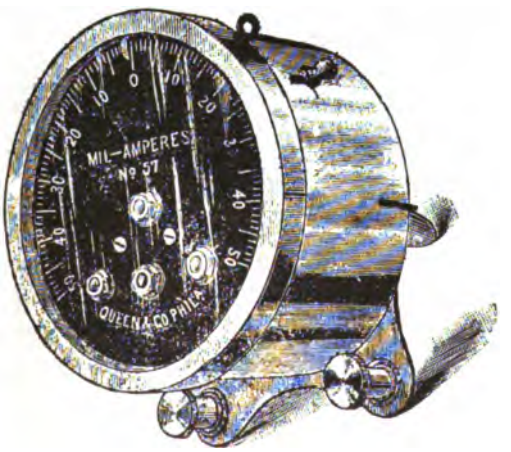


FIG. XI.—Milliamperemeter (magnet type).

of annoyance to the operator, as the parts which compose it are of necessity inconstant and perishable. It is but natural, therefore, that the physician, surgeon, or dentist who is making use of electricity in his practice should desire some source of electricity that would rid him of these annoyances. This relief is now afforded by the dynamo

currents which are coming into such general use for illumination and the supply of motive power. The current supplied by these dynamos needs to be modified to meet the requirements of the physician and surgeon, and a number of instruments have been devised with the view of modifying these currents and making them available for therapeutic purposes.

These modifications have afforded in the main two distinct methods. The one introduces into the current, as a direct resistance, some form of resistant wire or graphite, which, together with the body, brings down the current to the required amount. The other form makes the

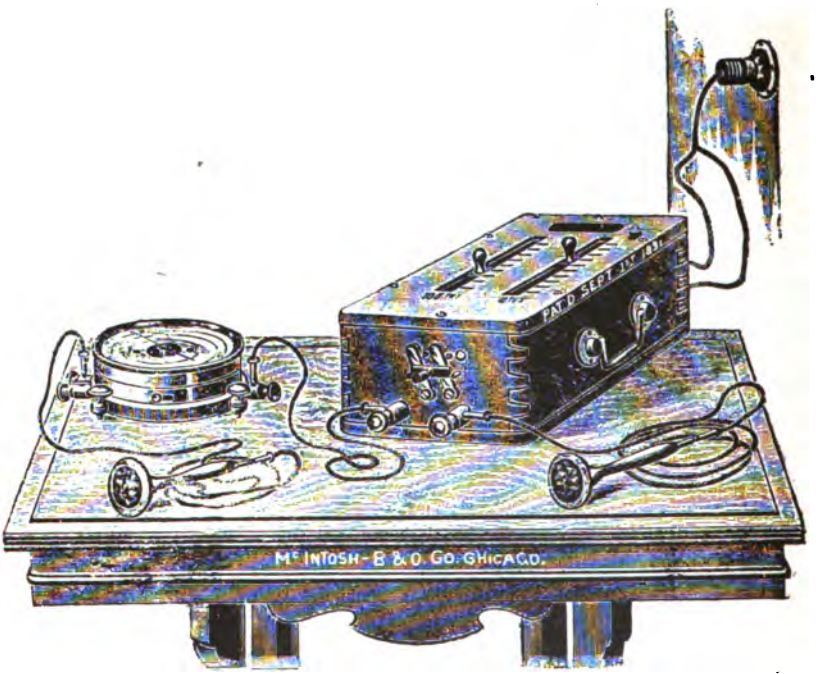


FIG. XII.—Dynamo-current controller.

body a part of a shunt circuit, which can be modified at the will of the operator, permitting a greater or less quantity of current to traverse the body from the main supply. Some of these appliances are very efficient, and are destined to come into more popular use as the dynamo currents become more available. The apparatus intended for electric application are thus greatly simplified; the use of electricity is made in this manner much less formidable than it has hitherto been, both to the physician and patient. Illustrations of several of these forms of current modifiers are here represented. A detailed description of them would be interesting, but the limits of this report prohibit fur-

ther explanations. The introduction of this class of instruments, however, marks a new era in the science of electro-therapeutics. When the constant current is employed for the purpose of heating cauteries or lighting exploring lamps the conditions to be met differ materially from those that exist in application of the current to the body where the resistances are variable and comparatively great. The electro-motive force need not be so great, but the amount of current required is larger. For doing all kinds of cautery work a current capacity from 2 to 30 amperes is required, and although none of the exploring lamps need so wide a range of current as this, they could not be satisfactorily furnished for any length of time from a series of primary batteries connected up for high voltage where the external resistance to be met is greater. If primary batteries are made use of, therefore, for heating cauteries and lighting exploring lamps they must be very differently constructed from those described above. This construction must be such as to prevent polarization or provide for this rapid depolarization, for the internal resistance must be very greatly reduced in order to correspond with the low degree of external resistance.

FIG. XIII.—Current adapter.

Secondary batteries, or accumulators, have not yet reached such a degree of perfection in their construction as to make them reliable instruments for the physician or surgeon where the cautery or exploring lamp is needed. Even if much more reliable than any yet furnished, the care needed to keep them properly charged is a great obstacle to their use. Unless a satisfactory dynamo current is at hand, therefore, some form of primary battery is still the most satisfactory for generating a current suitable for these purposes. The bichromate of potash battery, with zinc and carbon elements of large size, and coupled in parallel, and provided with a resistance for varying the current with ease and nicety, is probably the most serviceable instrument when the dynamo current is not available. The illustration presents one of the best of these which was upon exhibition at the fair. The same tendency which has been shown in adapting dynamo currents to therapeutic uses, is also seen in the construction of the instruments for utilizing these currents for heating cauteries and illuminating cavities of the body; and wherever the dynamo current

can be obtained, it is much more reliable and satisfactory for these purposes than any form of primary or secondary battery. There have been a number of efficient instruments constructed recently for the purpose of modifying both constant and dynamo currents, so as to adapt them for heating cauteries and lighting lamps suitable for medical and surgical uses. Illustrations for one or more of these will appear under the description of alternating-current apparatus.

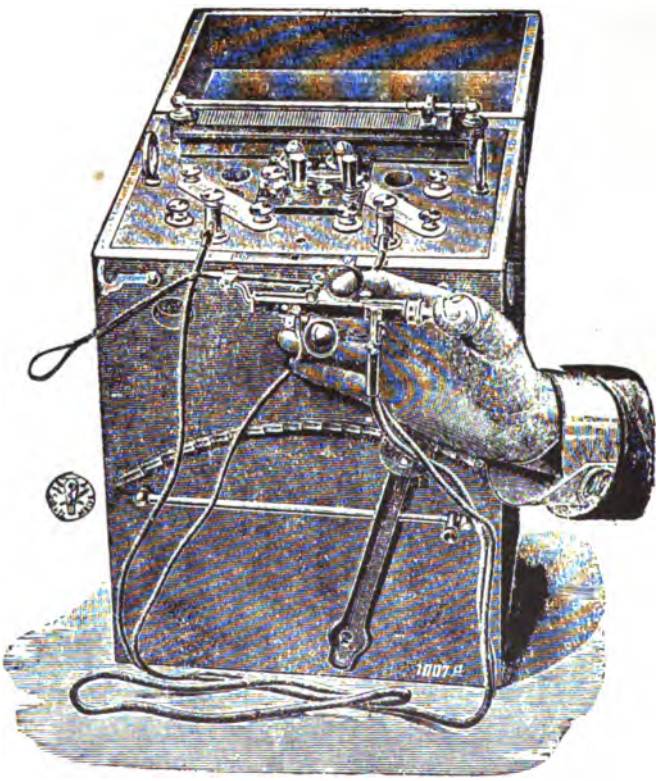


FIG. XIV.—Cautery battery.

THE INDUCTION CURRENT.

Another distinct class of physiological phenomena is produced by the action of induced currents upon living tissues from that which is the result of constant current action. The methods of generating induced electric currents require a mechanism peculiar to them. Attempts have been made to employ induction electricity in therapeutics from the time of Faraday's discovery up to the present day.

A long series of apparatus for the application of induced currents to the body, increasing in improved mechanism step by step, indicates the study and thought this subject has received, until now the limit of

efficiency can be said to be almost reached. The essential features of the simplest form of physicians' induction coil consists of a primary and a secondary coil. The initial energy is usually generated by some form of primary battery, and is made to traverse the primary coil through a spring interrupter, alternately attracted and set free by a temporary magnet, which is made to gain and lose its magnetism by virtue of the intermittent current flowing in the primary coil which surrounds the magnet. The secondary coil, composed of much finer wire than that in the primary, and with more frequent turns, is made to move over the primary at will. The terminals of the wires of each of these coils are made to connect with the patients' circuit, so that either the primary or the secondary current may be utilized.

The efficiency of these instruments depends, first, upon the initial source of electric energy; second, upon the character of the interrupter and the frequency of its vibrations; third, upon the size and

FIG. XV.—Simple medical induction coil.

length of wire forming the primary coil and the number of its turns; fourth, upon the nature of the materials forming the temporary magnet; fifth, upon the size, length, and number of turns of wire composing the secondary coil. Experience has shown that the physiological effects produced by currents derived from these instruments are directly dependent upon each of these factors.

In general terms, the initial voltage and size of wire and number of turns determine the electro-motive force and the current derived from the primary and secondary terminals, while the rapidity of the vibrations caused by the interrupter determines the frequency and continuance of impulses to which the tissues are subjected. It can be seen, therefore, that the most efficient instruments, other things being equal, and those which permit the widest range of therapeutic effects, would be such as are constructed so as to allow variation in the initial energy and frequency of interruptions and the amount of wire exposed to the inductive influence.

As the work in therapeutics has advanced, the demands for instruments of wider range and greater efficiency in producing induction currents has stimulated ingenuity to devise some excellent apparatus of this class. The most perplexing problem which these mechanics have had to deal with is that of producing a reliable vibrator. The number of vibrations being an important factor, it is essential that they be accurately determined and recorded by reason of the physiological effects for the purposes of comparison.

An inexpensive method for this has not yet been discovered. Some foreign manufacturers, by means of clockwork attachments, have succeeded in a somewhat cumbersome way in meeting this requirement. The latest device, and that which received the sanction and award at the Fair, is one in which the interruptions are brought about by an insulated wheel, on the margin of which metallic segments were placed at regular intervals and connected with the primary coil. The wheel

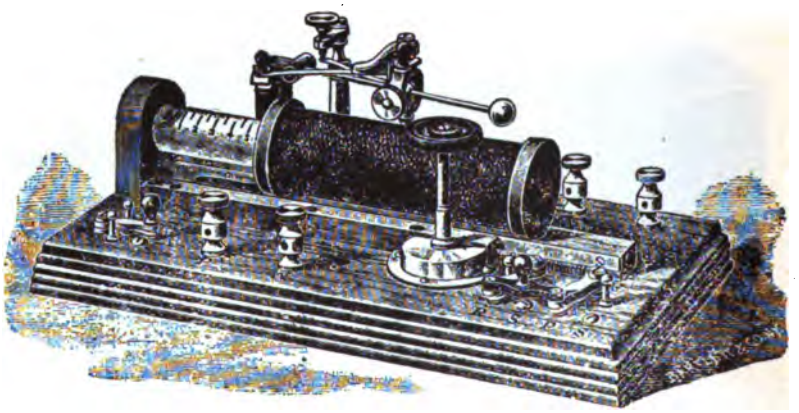


FIG. XVI.—More complete medical induction coil.

was caused to revolve by the power furnished by a small electric motor. The speed at which it revolved was readily determined, and at each revolution a metallic brush, suitably connected, came in contact with the metallic segments, and completed the circuit. By varying the speed of the motor, as well as varying the number of segments exposed to the brush contact, the frequency of the interruptions could be made to cover a very wide range at the will of the operator, and their number could be determined with mathematical accuracy.

Without these improvements in medical induction apparatus uniform results in therapeutics are not to be expected, since instruments that differ in action necessarily differ in physiological and therapeutic effects, as well as have no basis for comparison by operators using different instruments. All progress in exact science requires a standard for reference. The science of electro-therapeutics, therefore, to be built up from the action of the induction currents upon the body, must needs start with instruments that can be depended upon to act at

all times in the same manner. The current which is derived from the secondary coil of a medical induction machine is a to-and-fro alternating current, its polarity changing at each vibration of the interrupter, but as there is an instant in which the current is completely arrested, and the current of the "break," by reason of the fact that it does not meet the opposition of self-induction, is stronger than the current at the "make." The graphic curve that would represent the currents of the secondary coil is not uniform, consequently the physiological effects produced by such currents differ considerably from currents which are more uniform in their alternations, such as are generated by alternating dynamos, for in the latter the to-and-fro action is not attended by any absolute interruption, since the self-induction influence is equably distributed. Physiologists and physicians very early recognized that in the alternating current the sinusoidal action pro-

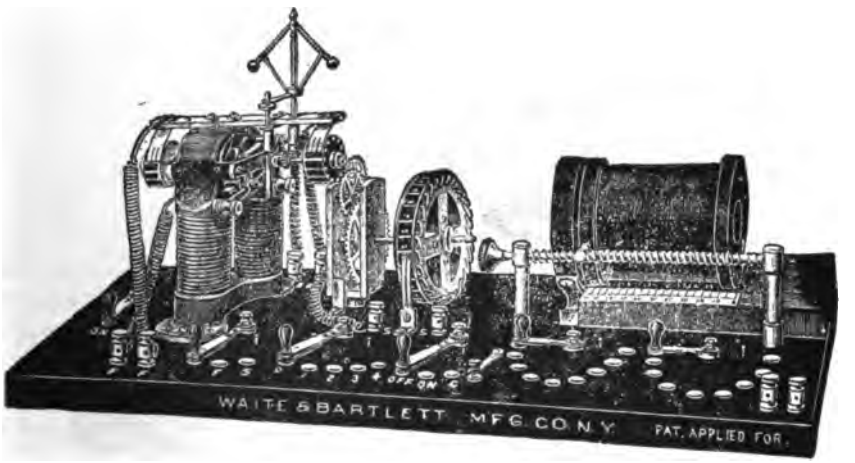


FIG. XVII.—Medical induction coil with improved interrupter.

duced physiological effects peculiar to itself. This form of inductive action has been too recently available for medical uses to permit much to be said concerning its efficiency as a therapeutic agent, yet very much experimentation has been conducted by means of it, and it gives promise of valuable assistance in the treatment of certain diseases resulting from imperfect oxidation and faulty excretion. Induction currents, alternating or sinusoidal in character, can be derived from instruments specially constructed for the physician's use, such as the one here illustrated.

The current which is furnished by alternating dynamos, such as those employed by the Thomson-Houston, or Westinghouse company's for incandescent lighting, have in some instances been turned to account for therapeutic uses. By means of suitable transformers, these dynamo currents can be made to serve the purpose of alternating,

or sinusoidal currents in direct application to the body, and by certain modifications in the transformer they can be made to heat cauteries, and light lamps for diagnostic purposes. This form of current is coming into very general use for in-door lighting. The many ways in which it can be made to serve the physician and surgeon will bring this class of transformer, in time, very much in demand. The illustration here presents one of these transformers, arranged to vary the strength of current as it is derived from an alternating dynamo. This is the only one of this class of instruments that was on exhibition at the Fair, but many other designs constructed with the same purposes in view, but differing in range of action, are now manufactured both in this country and abroad, and are destined to come into very general use.

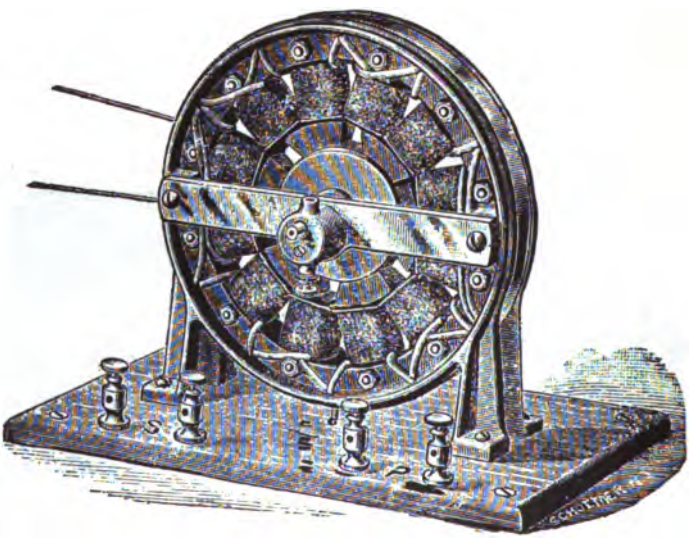


FIG. XVIII.—Physician's alternator.

The alternating currents which are derived from dynamos, whether specially devised for physicians' use or not, depend for the frequency of alternations upon the rapidity of the revolutions of the dynamo. These revolutions may be carried to such a speed that the alternations in the current are far in excess of the number of interruptions that was possible for any of the older forms of physicians' machines to approach. The best vibrators of the old induction machines were seldom made to exceed 3,000 interruptions per minute, whereas the ordinary alternating dynamos, at their usual speed, give from 9,000 to 10,000 per minute, and could be made to greatly exceed this number.

The physiological response on the part of the tissues of the body to impulses of this character has not yet been determined, neither have the full effects of the changes, chemical or otherwise, which such

energy occasions in the compositions of tissues been made out. Experimentation has already revealed that the frequency of the alternations of the electric impulses impinging on the tissues bear some direct relationship to the nutritive processes going on within them. Physiologists like D'Arsonval, following the suggestions of Tesla and Elihu Thomson, have sought experimentally to determine the action upon the human organism of alternating currents of higher potential and frequencies in alternations than any that have yet been produced directly from the dynamo.

In securing these very high frequencies, advantage has been taken of the inductive influence of condensers, by means of which the alternations can be carried as high as millions or even billions per second. Induction currents of this character have not been employed, as yet, or at least not to any extent, in therapeutics. The physiological action, however, which seems to result from their application to the body, would indicate that they, likewise, have a part to play in therapeutics of no unimportant nature.

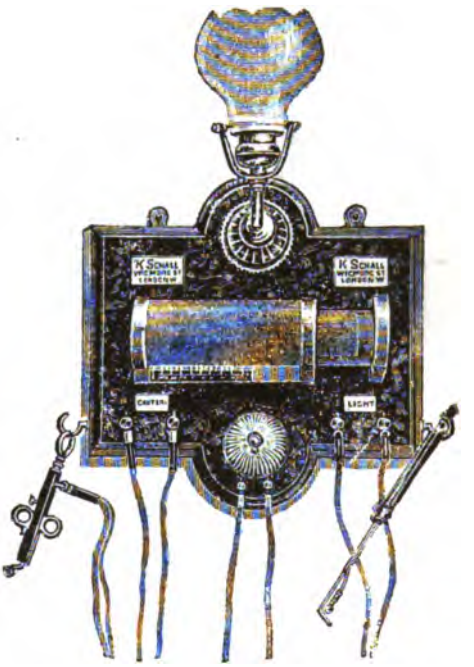


FIG. XIX.—Transformer for medical and surgical use.

Static or frictional electricity is the form in which this agent has been known for the longest time to the medical profession, and although it has not been in very general use, its value has at no time been entirely lost sight of. The treatment of certain classes of functional disorders, especially those of nervous origin, have found their proper treatment by means of the static spark or charge derived from the friction machine. While this form of electricity has been credited with very great efficiency by all who have become familiar with its use, yet the difficulties that have attended the construction of any form of static machine that could be relied upon at all times and under all conditions have proved a serious impediment to the general use in therapeutics of this form of electricity. The cost, also, of such machines has been a serious drawback. Within recent years static machines for physicians' use have not only been greatly improved in workmanship, but constancy in action is now very generally secured.

The range of action of such machines has been greatly extended by utilizing the induction currents which they are capable of producing as well as the direct static charge. These changes and improvements have greatly increased the demand for them, while the cost, at the same time, has been much reduced.

In this class of instruments the American manufacturers are far in advance of those of any other country, and while it can not be said that static electricity is more popular in this country than it is abroad, since in France, at least, it has many strong advocates, yet American enterprise has devoted itself to the perfecting of instruments of this class until now the modern instruments furnished by several makers

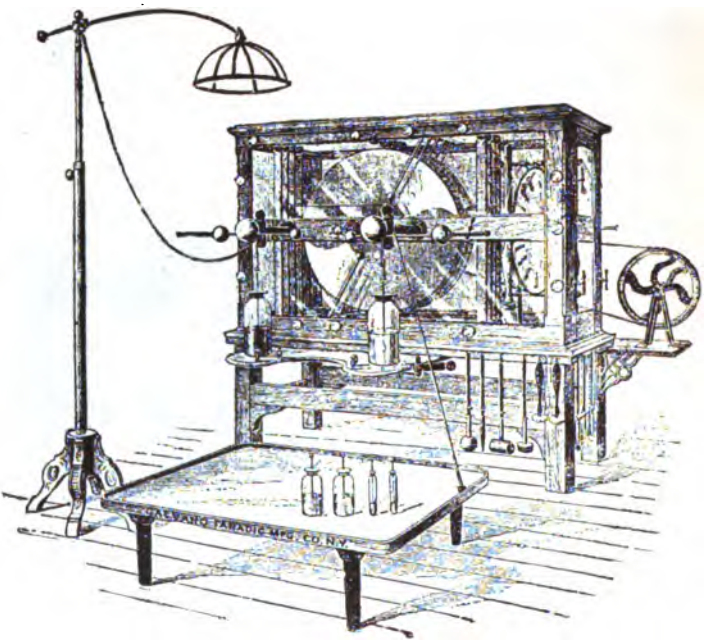


FIG. XX.—Static machine for physicians' use.

in this country leave little to be desired. These instruments are capable of generating at all seasons of the year, no matter what the atmospheric conditions are which surround them. They differ in capacity according to the number and size of the stationary and revolving plates which enter into their construction and the perfection of the insulation. The Holtz, or Toepler-Holtz form of construction, are those which have been found most successful in instruments of this character for physician's use at the present day.

I have attempted in this brief sketch to give no more than an outline of the various ways in which electricity is being applied to therapeutics. It would require volumes to do justice to the activity and inventive ingenuity which the interest in this subject has awakened within recent

years. Numerous lines of application, which I have not been able to more than hint at in this brief summary, have each been promptly furnished with a great variety of appliances to the utter bewilderment of the uninstructed novice who attempts to make a selection for an office equipment. Electricity has a distinct and important rôle to play in medical and surgical therapeutics, and he who would make use of it with benefit to his patient, needs not only perfect familiarity with the construction of the instrument that he employs, but also with the physical and physiological action of the energy derived from that instrument. When medical educators have been thoroughly awakened to the necessity of providing instruction of this character, the efficiency of electricity as a therapeutic agent will be universally demonstrated, and the misuse to which it has long been put through ignorance or design will naturally subside.

EMBROIDERY AND NEEDLEWORK.

BY

MARY IMLAY TAYLOR.

EMBROIDERY AND NEEDLEWORK.

By Mary Imlay Taylor.

The needlework, of both classes and all kinds, from Great Britain was divided into sectional exhibits, the English, Scotch, Irish, and Welsh exhibits being separate and distinct. The English section devoted to embroidery compared with the other foreign sections in the woman's building was not large, and the major part of the exhibit was entered as class 669. In fact, almost all the work was entered as art, embroidery, and needlework. There was a tendency on the part of all exhibitors to enter work in the highest class, and England was no exception to the rule. Whether the discrimination made by the exhibitor would have been made by the juror is a pertinent question.

There was a great deal of purely conventional work in the English exhibit—large designs, scroll patterns, and peculiar combinations of color not always pleasing to the eye of the American judge. The display of the South Kensington School was not as large or as striking as was naturally expected. England does not seem to have made a great effort to compete with American work, or even with the work of other nations. Perhaps the advancement of woman's work was not so important in English eyes as in ours. American women recognized and rejoiced at an opportunity to display their proficiency in all directions.

There were several examples of the green and yellow effects that recall the days of Oscar Wilde, especially one strip of green cloth embroidered with prim, vivid jonquils. Also a few embroidered pictures, and here some fine work was done in the draperies of the figures. One poor little embroidered lamb, holding the inevitable shepherd's crook under his little elbow, was almost pathetic in his dismal anatomy, his little hind legs being attached by accident, and without exact attention to his possible locomotion. There were several curtains decorated with large designs, but the coloring was not pleasing, although one of them was a curious example of blending. A plush border worked with flowers by Miss Allotte of Alford, Lincolnshire, was worthy of notice as an example of a new and fashionable style of work in England. The design showed large yellow flowers, transferred work, the outer petals standing out from the surface in a realistic imitation of the curve of the natural petal. The work was not

artistic, and received no award, but it was a sample of a new fashion. On the other hand, Miss Garnett's new work received an award, but that being entered as class 669, is out of the sphere of this report. There was an exhibit of fine needlework that compared favorably with the other similar exhibits, and there were specimens of work from the Princess of Wales's charitable industrial school at Sandringham. A small but interesting display of the native Indian work was very effective and unique. The colors were especially worthy of notice; there was harmony and tone in their rich effects, and the technical execution was good when the standard of the native work is considered. It was interesting that the Empire of India should have even its exhibit of needlework. One lovely piece of flame color, embroidered in pale gold, was beautiful.

THE SCOTCH SUBSECTION.

This section was almost entirely an industrial display. The Scottish Home Industries Association was originated by the late Countess of Rosebery to foster Scottish industries. The Princess Louise of Lorne is the president of the London board of managers, which is composed of distinguished people. This association made a display of homespun tweeds, Gairloch stockings, Shetland goods, Fifeshire handloom linens, etc. The exhibit had been displayed at the Imperial Institute at Glasgow before being sent to the Columbian Exposition. There were Tartan hose from Argyle, socks, gloves, and stockings from Aberdeen, and embroideries. These embroideries, many of them, were Turkish in design and coloring. It seems a pity that Oriental designs have so far usurped the place of original ones—that nationality is not more definitely represented in all work. Industries form an integral part of national civilization, and they should be stamped with national characteristics. The life of a nation should be vigorous enough to send its blood pulsing even to its smallest extremities. Something national, characteristic, unique, is what we want, even in needlework.

There was, to be sure, the Earl of Kinghorn's bedspread, embroidered in 1660, which ought to have been sufficiently eloquent of national pride in relics, and also the portière worked by Anne, Countess of Aberdeen, in 1740, both interesting as furnishing an example of the needlework of past generations.

The Scotch exhibit was not large but one of interest, and here, as in all the British exhibits, were signs of the growing cottage industries, fostered and encouraged by the wealthier classes, worthy of consideration as a direct indication of a new and healthful interest felt in the struggles of the poor—a sign of that broader human sympathy which will be a more effectual agent in healing class dissensions than any legislation which the world can ever see.

THE IRISH SUBSECTION.

The Irish subsection was mainly devoted to laces. There were two embroidered chasubles exhibited that fairly represented Irish ecclesiastical embroidery. In the English cases there were several pieces of work entered by the Irish Women's Work Society, some very creditable work. But the genuine effort to display and emphasize the Irish embroidery and needlework was made in the Midway Plaisance in the two Irish villages, which, after some natural hesitation, were entered for award. It had not been considered desirable to send the jury into the Midway Plaisance at all, as it was not a legitimate part of the Exposition, but the charitable nature of the exhibits in the Irish villages in itself established a claim for consideration. There is an earnest movement going on in Ireland to encourage the cottage industries, and it is an effort that deserves recognition and praise. Even to a foreigner, who can not wholly understand the condition of the Irish peasantry, this work of establishing home industries is one of great interest. That it is reviving the flagging energies of the poor and opening a new field of employment to the starving is undoubtedly true. The brave women interested in this work have with great labor and expense introduced home industries similar to those of the Bohemian and Swiss peasants into the congested districts of Ireland.

Lady Aberdeen's beautiful exhibit of Irish lace is a striking example of that industry, and her embroidery and needlework claim attention.

Mrs. Ernest Hart, the secretary of the Donegal industrial fund, has also an interesting exhibit, and one that demands especial consideration. She displayed work that was entirely national—embroidery on Irish poplin and Irish linen from Irish designs, and worked with Irish flax threads. The "Kells embroidery" is distinctly Irish; wrought on colored linen from the handlooms of County Armagh with the polished flax threads, it presents a characteristic effect. It was originally designed to aid impoverished Irish gentlewomen, but it is also taught to the peasant girls. Miss Aimee Carpenter, of Croydon, adopted many of the original designs for this work from Celtic missals of the seventh and eighth centuries. The weaving of the art linens for these embroideries has opened another field for industry.

All this work has received recognition and encouragement from Queen Victoria. It deserves the highest consideration and success. It is certainly an unselfish motive that has prompted these women to foster the home industries of Ireland, and by so doing to open a new and fair field of labor for the Irish peasant woman. It should especially appeal to the women on the jury of awards, since they were called to judge of the advancement and to encourage the work of women from almost every nation upon the face of the earth.

THE WELSH SUBSECTION.

The most conspicuous objects in the Welsh exhibit were two hand-made quilts, not very artistic in coloring, but solid and comfortable looking, and marvelous examples of hand quilting, which received awards as samples of that class of needlework. There were also some samples of embroidery and needlework—one large bed coverlet worked in browns and ivory tints, that was also conspicuous, a conventional design neither very artistic nor especially well executed. The exhibit was not large, and here, too, there were signs of the cottage industries. The slow Welsh weaving was shown by the operations of a hand-loom. For a small display of woman's work it was well arranged and creditable.

THE DOMINION OF CANADA.

The Canadian work—two cases of embroidery and needlework—was displayed in the manufactures and liberal arts building. Here, too, there was very little work entered as class 665. There were some very creditable embroidered initials on handkerchiefs by Mrs. Ernest Wurth, and some very dainty netted doilies by Mrs. J. Thomson, of Fergas, Ontario. There was a pair of slippers embroidered in the Chinese style that were worthy of notice, some Mount Mellick work, and a good deal of embroidery in the conventional style. As a whole, the Canadian work was not artistic and did not show that progress in design or execution that might have been expected. The reports of the individual judges will sustain my opinion in this respect.

MEXICO.

The work of the women of Mexico was conspicuously represented at the Exposition. Their painting, their embroidery, their drawn work, their curious fish-scale flowers, all had place and consideration. Mexico had no woman representative on the jury of awards, but the work of the Mexican women spoke clearly of their advancement and of their proficiency in feminine occupations, especially in those that are peculiarly domestic. It was long ago admitted that they excelled in drawn work, and they have worthily sustained that reputation at the World's Columbian Exposition. The exhibitors from other countries, in no single instance, displayed drawn work in such profusion or of such exquisite delicacy. Mexico easily ranked ahead of all other nations in this peculiar kind of handiwork; whether it was the drawn work upon one piece of linen, or the drawn-work inserting, it was equally creditable and skillful in execution. And their fine edgings, crocheted and done with the needle, were marvels of delicate beauty, the "Brazilian lace" edge on one handkerchief receiving an award. The display of drawn work was elaborate and exhaustive;

everything from a chemise to a pocket handkerchief was in evidence to represent some new variety of pattern or stitch. Some of the drawn-work yokes to the chemises were exquisite. The deft Mexican fingers weave these cobwebs to the discomfiture of the needlework world.

Their embroidery can not be judged by the same standard. The designs lack originality. The vital spark of art work has never been kindled. There is an eternal monotony in the little sprays of flowers and Spanish mottoes that decorate one corner of every handkerchief, with a few exceptions. Their notions of color, too, are very crude and often vividly inharmonious. It was very apparent that the finest embroidery was all white. They have a decided tendency to elaborate details. Their work is minute. There are no large designs worked for effect; no free-hand; everything is finely and exactly done; every stitch seems to be counted and fastened in its peculiar place with unfaltering patience, the patience of sublime docility. It is characteristic. It is national. It seems as if the intensely domestic life of these women stamped itself upon their handiwork. The liberty of thought that has enlarged designs and made the execution of all work easier, from the work of the needle to that of the sledge hammer, has not yet penetrated Mexican conservation.

Another point, and one always pleasing to the eyes of the jurors, was the cleanliness of this work; in spite of the long journey, it was neither travel-stained nor tumbled. There was a neatness, an immaculate whiteness, that was refreshing about all the cambrics and linens.

The fine work was exhibited in the Mexican section of the women's building, and was very well and daintily arranged. The overflow, as it might be termed, of this exhaustive exhibit, was in the manufacture's and liberal arts building, but there could be no comparison between the two sections, as the reports of the individual judges plainly showed. There was a good deal of work exhibited by the woman's auxiliary board of Mexico, but the mass it was sent by individuals.

One example of the minute and beautiful work was a tiny baby sack sent by Rosos Laseto, of Moselas, which was covered with such exquisite drawn work that it received an award. Maria Napoler, from the same place, also received an award for fine drawn work, and Terrano Trinidad exhibited a drawn-work yoke for a chemise which won an award. The awards, and there were many, were given largely to the drawn-work exhibits.

The embroidery did not compete as successfully, but there were many instances where the drawn work and embroidery were happily combined, as in the case of a handkerchief exhibited by Charave Trinidad, of Nuero Leon, which received an award for excellency in both drawn work and embroidery.

ENAMELS.

BY

E. CRAWFORD.

ENAMELS OF ALL NATIONS, AS EXHIBITED IN THE COLUMBIAN EXPOSITION.

By E. Crawford.

Every nationality seems to have taken to itself some peculiar feature of this art and make it its characteristic, so that the styles of the different countries could be recognized at a glance. Formerly the practice of the style was inseparable to the country, but now the manner is copied and produced everywhere, with the exception of India, whose preparation still remains a sort of family secret—notably in the cases of the Pertaubghur green enamels, which together with the Rutlam, are not true but quasi enamels. About them there is no reliable information to be had. Of the Jeypoor enamels, which are the finest of the Indian kinds, we know that the artists will not work willingly on any foundation but gold, maintaining that pure metal is necessary for good work. This is to a certain extent correct; still fair results can be obtained on 22 or even on 18 carat gold. Silver enameling is frequently made of good quality, still they do not work with any pleasure in it. Gold also has the greatest range of colors, as all the colors known can be applied to it. The base of each color is vitreous and the coloring matter is the oxide of a metal, such as cobalt or iron. Of all the colors the pure ruby red is the most fugitive, and only the experienced workman can bring out its beauties. The production of a pure, fine red color appears to be attended with considerable difficulty in all materials. The "reds" of ancient times were undeniably purer and more brilliant than those now obtained. Italy has instituted a prize for red enamel, but the prize has not been taken yet by anybody. The Russians succeed in producing a rich transparent red of great beauty, but it is a "carmine" red and not the true "vermilion" "rouge cardinal."

A silver base only admits of the application of black, green, blue, dark yellow, orange, pink, and a peculiar salmon color, while on copper only white, black, and pink can be employed. This applies to Jeypoor enamels exclusively.

Enameling in America does not appear to be largely practiced, but the firm of Tiffany & Co. are working in this direction, and have sent some lovely pieces which in point of taste and execution would be difficult to surpass; indeed, the small enamels of this firm are perfection in finish and color. One tiny box in pale yellow and green, of

most delicate shades, with a minute cluster of diamonds at the opening, is a charming example of taste, as are also two small scent bottles in curious green and brown enamels, respectively in Siamese and Japanese styles. The enamel is treated as a jewel itself, and with the respect it deserves. Fine effects are obtained by combining precious stones with enamels of harmonizing colors. Enamel is too beautiful and artistic a substance to be applied to "banal" subjects, as we unfortunately see it done sometimes. One regrets the time, patience, and skill wasted on silly or degraded designs which do not show the slightest artistic inventiveness, and are of a bad educational influence from the esthetic point of view, being intended to flatter the commonest taste of a public of the lowest average. In the Japanese section there are two or three bits of enameling that are jewel like and minutely splendid.

A good deal of attention seems to be devoted to translucid enamels this year. Russia must be acknowledged to go ahead in that industry as to the purity of colors and translucidness of the material. Gratcheff exhibits a lantern in finely colored transparent enamel. Some idea of the difficulties encountered in the production of such work may be gathered from the fact that this piece, which is not large, was three years in making, and two were spoiled before this third trial succeeded.

Dalman has invented a method of applying filigree to form the design or pattern on the enamel, but the effect seems to lack something, and is rather trivial.

Ouchiminikoff shows a collection of opaque enameled objects, in ancient Byzantine style, very noticeable from the beauty of the forms and the great richness of the coloring. Although these designs are well filled out they never strike the eye as being overflorid. Bearing that seal of sincerity and genuinity which characterizes all productions of the beginning of Christian art which they reproduce, they give you feel that restrained force in the ornament which is the acme of good taste. A special mention is due to a gorgeous punch bowl and cups of silver repoussé, gilt and with plaques of enamels both in cloisonné and filigree. This is a faithful copy of the original in the Kremlin of Moscow. Klingert reduces the wirework which separates one enamel from another to its minimum.

Hahn has not made of enamel a specialty, but he certainly deserves to be mentioned for the wonderful transparency of his enameled surfaces, which allow us to see through them the capricious and tasteful designs of the golden ground.

The enamels in Italian Renaissance style of Moritz-Keller (Germany) are deliciously fancied, and are used with the finest effects, chiefly as mountings for other gems, as lapis lazuli, rock crystal, and so on. There is a large plate of rock crystal with circular bands of enamels

and sectional bands of the same that leaves nothing to be desired in richness and workmanship.

Germany has some women artists in enamels who have sent their work here. Miss Amy Luthner exhibits a fine plaque in Limoges style, "The Triumph of Spring," after Holbein, which is an admirable work and wonderfully successful in keeping the drawing and expressions of the faces; the great difficulty of this lies in the fact that the paste must be applied in a very fluid state, therefore is liable to become confused.

The general effect of the enamels from Austria is somewhat poor; a faint purplish tone pervades them, the colors are not brilliant, and in the way of mounting there seems to be nothing new.

The enamels from France show considerable range, both of treatment and subject; their "pictures" in this material are especially good. This is the side of the art in which they are peculiarly excellent. Their women artists have sent many beautiful examples of their skill in using this capriciously difficult method of making painting permanent.

The transparent enamels are, of course, the most difficult to succeed with; the colors must be built up, bit by bit, how to make the semifluid remain between the few wires being the first problem to be solved, and few of the French enamelers seem interested in this as compared with other nations. There are only a very limited number in the section, and those are in the exhibit of Charlot Frères, who have sent two teacups in transparent enamels. One has the largest surface in white with colored designs running over it; the circular ring at the bottom, harmonized in blue and green, is of an extraordinary brilliancy and beauty. The other cup has the largest spaces of a fine warm green, with medallions of pale yellow softly shaded into orange, with almost the effect of a jade and onyx transparency. Louis Ancot sends a miniature surrounded with small diamonds, with a frame-like setting in brilliant enamels that is exactly what a jewel should be. Boucheron shows some small carved ivories which have enamels sparingly used as gems, and are very effective. Christofle & Co. have a full coffee set, enameled on gold with a kind of Egyptian pattern, cream and red—very dignified as well as luxurious. Taxile Doat has some specimens in the art gallery—one, a Venus and doves, has a very fine red ground. On the whole, the French exhibit of enamels, if not very large, is distinctive and choice; the majority of the pieces are works of art complete in themselves, and not merely ornamental adjuncts to objects of use.

The jewelers of Denmark and Norway have a great many enameled articles "in quaintest shapes and diverse colorings." P. Hertz and V. Chriestisen, both of Copenhagen, with R. Jensen, of Horsens, send every variety of spoons, forks, saltcellars, etc.—every conceivable thing for the table. Mr. Hammer, of Bergen, has a transparent cup and saucer and some little dishes—transparent also. L. Tostrup, of Chris-

tiana, has a pretty display in antique styles. David Andersen, of Christiana, sends two large table lamps, whereof the globes are made of colored transparent enamels and the stands of cloisonné; the coloring is more pleasing than the form here.

The Turkish enamels are exceedingly pleasing, as also the few from Persia.

Siam has sent a very remarkable collection of real antiques (these have been all too rarely shown). They have many specimens of enameling among them—the red enamel, that especially difficult color to catch, being of great brilliancy; they are often used where the modern jeweler would place a ruby; there is one box of this color with diamond sparks which is as perfect as anything can be—the mixture of ruby-like enamel, diamonds, and richly colored fretted gold making a charming whole. Two curious boars' tusks, completely circular, have the broad root ends enameled as dragons' heads; here there are pieces of red that rival precious stones.

Belgium's enamels are in one small exhibit of M. Houy; simply spoons, or brooches, etc. These small enameled wares, however, have been sent from all countries in immense quantities. The prevailing idea of a "souvenir" seems to concentrate on "spoons," and every nation (except the English) has rushed forward to supply this want—from the East and the West, the North and the South they have come in countless numbers—in every style of color, and shape, and size, to take possession of every table in the land; or at least in the hope of doing so. It is evident that the taste for enamels is increasing as the art becomes more generally understood.

To resume our impressions on the present state of enamel manufacture, as it appears from what has been displayed at the World's Columbian Exposition, we must state that two countries have to be recognized as going ahead in this art, although the difference of processes used excludes all possibility of rivalry between them; these are Japan and Russia. All that is made by other countries can be classified in one of those groups which are brought to perfection by those two countries, and can not pretend to any independent originality. The house of Tiffany & Co., in New York, is the only one which is on the way of finding out a new process, in their so curious adaptation of "mineral enamel." The latter can not be regarded yet but as a raw, unfinished material, but if conscientiously elaborated and improved it will gradually lose its roughness and crudity, and will certainly bring up a new variety in the art of enameling.

The specific merits of Russian enamel have been enumerated. We must notice, in addition to what has been said, the great variety of plain colors and the skill with which big surfaces are covered without blemish and without letting the enamel run over even on curved surfaces. The Japanese enamel attains its highest perfection in the cloisonné, which will be treated of in the next chapter.

JAPANESE CLOISONNÉ.

By Mrs. E. Crawford.

This art of the cloisonné enamel has been so much practiced in Japan, has attained such a wonderful degree of perfection in that country, and has become such a specialty with Japanese people, that when we hear of cloisonné now we all take it to mean Japanese cloisonné exclusively. Among the wonderful specimens exhibited by Japan at the Columbia Exposition we must mention first of all those colossal jars in the art gallery, made expressly for this exposition, which are the largest ever made in this ware; they stand over 8 feet high. They are very fine specimens, although the enameling is not quite so perfect as in the smaller pieces. In the grinding some of the enamel has come out. Still, they are very magnificent, and are exhibited by Shiwoda, of Tokyo. There are four other pairs of very large vases in the manufactures building, all on red grounds. One pair on the red ground shows the white hawthorn pattern, which is very happily softened and harmonized by the introduction of doves, of tender "dove" colors, sitting among the branches. These and another pair are from S. Goto, of Yokohama. The two remaining jars have the finest red as ground, and are from Shirozayemon Suzuki, of Nagoya. Another jar, cold and somber in coloring, suited to the stormy subject, is grounded with darkest blue, the design being branches of apple blossoms blown by the wind, also from Shirozayemon Suzuki.

This extremely laborious process yet leaves great scope for the exercise of the inventive faculty of the individual artist. Varieties in color and subject are unending, no two pieces being exactly alike. There are over 8,000 pieces in this section.

There are two new departures in style that are very remarkable, in the Central Association's exhibit. They are both by the same maker, Sousuke Namikawa, of Tokyo. One may be described as the most refined treatment of the realistic that has ever been attempted in cloisonné. It represents a bowl filled with deep blue water, the color of a lake where it reflects the sky. About the rim (the surface of the lake) you see an occasional trail of lily leaves with its exquisite white flower—just a touch, no more. Deep in the water, or just curving out from under the lily leaves, are gray velvety-coated fish, with here and

there a sparkle and flash of tiny gold fish. It is impossible to describe the perfection of this piece. The wonderful harmonizing of the blue water, green weed, and gray and gold fish is not more wonderful than the extraordinary effect of distance and intervening element given to some of them, the delicious "line" of their movement, and, finally, the great art with which the "wiring" has been used—nearly lost in some places and in others made to serve as outline; for instance, in the scales of the nearest fish. A more lifelike rendering of the surface could not be given. It must be seen through a magnifying glass to be appreciated. An indescribable softness and harmony—a tone, as it is called in painting—pervades this lovely work. You seem to lose the idea of its being anything but what it represents, and you sink with the fish into the twilight of the cool blue depths.

The second piece, by the same maker, is also a triumph of technical skill and "idealized conventionalized" treatment. It is a small bowl of a shape higher than its breadth, its silver wiring in a pattern of conventionalized waves, with flights of tiny silver birds (used to hold the wires in place). The enamel is of an exquisite sea-blue color, and is transparent. The whole idea—a piece of the sea—is thoroughly carried through, and the effect is extremely beautiful.

The examples of cloisonné from Japan are simply unending, each different from the last, and almost all lovely. There is a disposition to withdraw the wire as much as possible, and in some instances it is entirely lost, with a very happy effect, although I think it loses its cloisonné characteristics somewhat if the wire be allowed to disappear altogether. A departure that I think is a mistake is the introduction of a "spangled glass" effect into the ground. This is an innovation intended to reach the Western fancy, and indeed I have heard such visitors admiring it with perfectly artless simplicity.

In going through the Japanese exhibit one is bewildered by the enormous variety, each one of the eight thousand or more being a unique specimen. To do them each justice a separate description would be requisite for every one. For the casual visitor the idea of grasping and recollecting in detail more than one or two becomes quite hopeless, and he finally carries away a jumbled remembrance of immense incense burners in fantastic forms; gigantic globes with multicolored dragons writhing around them; towering jars with whole gardens of pale flowers of the chrysanthemum blooming against their massive sides; others with a rich drapery (simulated) thrown with apparent carelessness over their broad shoulders. Every phase of nature has been drawn upon by these accomplished artists; every fleeting tint of atmosphere; every momentary movement of bird or beast, fish or mythical monster, has been seized and set forever into the imperishable metal.

Where all are so good it is hard to pick out individuals; still some

have more remarkable exhibits than others. Yoshitano Kamano, of Yokohama, has a large exhibit in various styles. A splendid pair of large vases have a dark-blue ground with sprays of wisteria blossoms; a fine incense burner, very varied in form, and rising to a great height, are among the very finest cloisonné work, while a small vase of the "lost wiring," in a beautifully soft "jade" green, with faint impressions of white flowers on it, reaches the highest perfection in this style.

Suzuki Honda Vlo, of Nagoya, have an exhibit of many small articles, each one of the finest wiring and finish in workmanship and artistic design. They also show one fine and large jar covered with minute work of the greatest excellence. Varied as the tints employed are, the jar as a whole is beautifully harmonized into a soft brownish-green effect. The polish of this jar is remarkably good, and the surface of the enamel is quite flawless. A companion jar was made, but unfortunately was destroyed in the great earthquake of 1891, when over 1,000,000 people perished and thousands of houses and temples were burned.

B. Kawaguchi, a large manufacturer of cloisonné in Nagoya, sends a large exhibit of great globular and other jars, with much merit and enterprise in his selections.

N. Yamanoto, of Kobe, has some delightful lantern stands in sea blue, with dragons curling among the foamy waves at the base and phenixes flying around the bell-shaped tops, the sides of the lanterns proper being made of pierced brass.

Shirozayemon, Suzuki, Seizayemon, Isunekawa, Jinpei, Tsukamato, Bunzayemon, Kawaguchi, and Jinnoye Onta are all from Nagoya, and among them furnish a great quantity of cloisonnés. J. Ohta sends one very distinctive jar, representing a sunset sky, with a green landscape and the Temple of Niko. The effect of the dark trees against the sky is well given.

The Kausai Trading Company send large and lovely incense burners; Suzuki, of Nagoya, a "koro" (incense burner) of ancient design and perfect execution. The list of cloisonnés is never-ending, but there are a few specimens of enamel which must not be overlooked. They are all in one case. A small silver tray by Kobiashi, of Tokyo, has an open-work border of chrysanthemums in brilliant enamels and more of the flowers on the tray itself; T. N. Hiratsuka, Tokyo, little silver open-work incense burner, exquisitely ornamented with enamels; Y. Oseki, Tokyo, small silver flower vase, the base and neck diamond shaped and ornamented at the corners with enamels, the bowl being of cloisonné with a lovely pale-green ground design of colored phenixes, etc. This maker sends another delightful little object—a silver bowl with a highly relieved dragon in enamels at the bottom of it. K. Kobayashi, of Tokyo, sends a small silver flower vase, with here and

there a life-colored chrysanthemum enameled on the bowl, the handles made of two fluttering butterflies in blue enamels. He sends also a tiny teapot of similar design, but with the handle of carved ivory—a monkey climbing down a branch. The case contains the very choicest bits of the Tokyo exhibit and shows a small but very valuable bowl, imitating the old "Tmari" ware, quite a perfect thing in color and execution.

Space fails in describing the really wonderful exhibition that the Japanese have sent. The patience and skill and the time expended on it, together with the romantic details attached to many of the objects, make it, to my thinking, entirely the most fascinating of all the displays here. It is to be hoped that the Japanese will feel that their labors have been appreciated.

DIVISION OF ENTOMOLOGY, DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY, DEPARTMENT OF AGRICULTURE.

The exhibit made by the Division of Entomology attracted unusual attention and was uniformly complimented. It was notable not only for its extent, but for its comprehensive character and the manner in which it was classified and put together. Realizing that the various States might have exhibits of a similar character, Prof. C. V. Riley, entomologist of the Department of Agriculture, planned to make this exhibit as far as possible educational and an illustration of the methods of work in the Department. There were, for the popular eye, a few cases of brilliant and gaudy butterflies and moths from Central and South America. These gave color to the exhibit and attracted and pleased the ordinary crowds, and helped to make the exhibit essentially an American exhibit, but they were but a side issue and the student of entomology, the farmer interested in the practical bearings of the subject, and the foreigner desiring to learn something of the methods of work of our national Department, all found matter to hold them absorbed, to interest and instruct them.

The exhibit illustrated in a marked way the extent of the literature, the apparatus, the results accomplished, and the future problems of applied entomology, the extent and importance of which are hardly realized. The exhibit was classed under eight sections, as follows:

Sec. 1. Insects injurious to agriculture.—Exhibits 1–658.
- (*a*) Regular series, including corn and cotton. (1–602.)
- (*b*) Special series for wax material. (603–654.)
- (*c*) Anatomical models of insects. (655–658.)

Sec. 2. Systematic and biologic entomology.—Exhibits 659–713.
- (*a*) Systematic series.—Samples. (659–670.)
- (*b*) Biologic series.—Samples. (671–681.)
- (*c*) Show material (682–709.)
- (*d*) Solidago exhibit. (710–713.)

Sec. 3. Silk insects.—Exhibits 714–721.

Sec. 4. Professional exhibit.—Exhibits 722–787.
- (*a*) Collecting apparatus. (722–750.)
- (*b*) Rearing apparatus. (751–773.)
- (*c*) Apparatus and methods of mounting and preserving. (774–787.)

Sec. 5. Insecticides.—Exhibits 788–907.
- (*a*) General exhibit. (788–865.)
- (*b*) Patent insecticides. (866–907.)

Sec. 6. Insecticide apparatus.—Exhibits 908–1032.
- (*a*) Nozzles. (908–995.)
- (*b*) Machines. (996–1032.)

Sec. 7. Official publications of the U. S. Entomologist.

Sec. 8. Illustrations, maps, and charts.—List.

Section 1, under the head of "Insects injurious to agriculture," contained some 602 special exhibits, each of which was an object lesson and pictorial epitome of the life history of a single injurious species, including as far as possible the different stages of growth of the insect, with the injury it does, its parasites, the remedies to be used, and references to the chief literature on the subject. Supplementing these were noteworthy exhibits of certain special and widely known pests, including the hop-plant louse, the chinch bug, and the once notorious fluted scale of California, now sunk into innocuous desuetude. These insects were shown in enlarged papier-mâché models, in different stages, the fluted scale being accompanied by an enlarged model of the little Australian ladybird which cleared it out of the California orange groves three or four years ago. The exhibits in this section were grouped according to the plant or animal affected, and related to orchard, field, and garden crops, the parasites of domestic animals, and household pests, with a small collection of the insect enemies of forest trees. The value of object lessons such as these to the intelligent and enterprising farmer is very great, enabling him, as they do, to see at a glance just what a particular insect pest looks like in its different stages, the parasites which attack it, and the best remedies to use against it. As a rule he is already familiar with the nature of its work, but as the injured plants were shown, for the most part, side by side with uninjured specimens, he gained, in this case, a realizing sense of the importance of doing his best to suppress the pest.

Section 2, illustrating systematic and biologic entomology, was of interest chiefly to the student or professional entomologist. It showed, in a series of drawers, how the full life history of any particular species which has been studied is brought together in a series of specimens, whether in alcohol or pinned, for future reference and comparison. These drawers were actual samples from the collection of the National Museum, and showed not only the arrangement of a systematic and biologic collection, but gave an insight into the present status of the national collection, which is in charge of Professor Riley. In this section was also included the remarkable exhibit of the insects which affect the golden-rod, a surprisingly large number.

Section 3, silk insects, may be passed with brief mention, though interesting enough in itself, as the raising of silkworms has no economic importance whatever in the United States at present.

Section 4, the professional exhibit, showed the apparatus used by the professional or amateur entomologist in the collection and preservation of insects, their mounting and rearing. The familiar, traditional butterfly net was here in large variety, but there was besides a bewildering display of the other tools a modern entomologist needs in the prosecution of his work. Of chief interest among these were the different devices and methods for the rearing and breeding of

insects, comprising a large variety of cages, vivaria, and breeding jars. The section, as a whole, gave a complete illustration of the apparatus, implements, and methods of work of the practical entomologist.

From the farmer's point of view section 5 was probably the most interesting and important. It was devoted to insecticides, not only those which have been devised in the work of the entomologist of the Department of Agriculture, but some of the more important patented articles. Some eighty samples of unpatented insecticides were shown, of which about a dozen were of supreme importance and fulfill all ordinary needs, the others being of only occasional value. The proprietary and patented articles were exhibited without comment, as all practical requirements in the way of insecticides are met by the unpatented articles exhibited; a fact which will be a greater gratification to the farmer than to the patentees of the proprietary articles.

Section 6 bears a close relation to section 5, as it comprised exhibits of the machinery—pumps, spraying devices, etc.—which is used in the applications of insecticides. A feature of this exhibit was a series of trial nozzles experimented with during the evolution of the now well-known Riley or Cyclone nozzle.

Sections 7 and 8 illustrated the literary end of the work of the Division of Entomology. Section 7 comprised the official Government publications, including both the work of the Division of Entomology and that of the United States Entomological Commission, now complete in five large volumes. Section 8 was a very complete exhibit of the illustrations published by Professor Riley in his official capacities as State entomologist of Missouri and United States entomologist. These illustrations, amounting in number to several thousand, and mounted on large sheets with references to the publications in which they appeared, represented the best series of delineations of insects from any one source ever brought together. To complete the picture of the work and methods of work of the Division of Entomology, illustrations from large photographs were shown of the interior of the divisional offices with the working force in situ.

ETHNOLOGY.

ANTHROPOLOGY.

By Prof. O. T. Mason.

For the purposes of exposition, anthropological material divides itself into the following classes: First, living members of the different types, stocks, tribes, and nations of mankind; second, skeletons and soft parts of the human body preserved in alcohol or cast into some sort of durable material, together with corresponding parts of other animal structures with which the human body enters into comparison; third, objects associated with the activities of mankind in every sphere of life; fourth, pictures of men and things in action. These are very important and bear the same relation to specimens that physiology bears to anatomy; fifth, descriptions in the shape of labels, printed or written, catalogues, or monographs.

At the World's Columbian Exposition there were live specimens of all the great types of mankind—smooth-haired, wavy-haired, and woolly-haired. In the hurry it was not possible to catalogue them and ascertain whether every small variety was represented, but there were natives from Africa, various stocks of Malayo—Polynesians, Asiatics, and every variety of Europeans and American aborigines. There may have been Australians also, and Hottentots, which would complete the list. But omitting live peoples—whether we take the classification of Mueller, Haeckel, Huxley, Flower, or Brinton—every type of mankind was represented at the Chicago Exposition in its works. On the Midway Plaisance, in the state and foreign buildings, in the Government building, in the manufacturer's building, as well as in that of transportation, machinery, and agriculture, and, finally, in the anthropological building, systematic exhibits were made of the two great branches of anthropology—namely, somatology and ethnology.

The following classification of anthropology will show the departments of the sciences and their relation one to another.

NATURAL HISTORY OF MAN.

ALL MANKIND AS NATURAL OBJECTS.—ANTHROPOLOGY.

WHAT MAN IS.—*Structural Anthropology.*

The embryo of mankind and life of the individual	*Ontogeny.*
The body of man, specific and comparative	*Anatomy.*
The functions of the body	*Physiology.*
Form and color, weight and number	*Anthropometry.*
The nervous system in relation to thought	*Psycho-physics.*
Natural division of mankind	*Anthropotaxis.*

WHAT MAN DOES.—*Functional Anthropology.*

To express his thoughts	*Glossology.*
To supply his wants	*Technology.*
To gratify his tastes	*Æsthetology.*
To account for phenomena	*Science and Philosophy.*
To cooperate in the activities and ends of life	*Sociology.*
In presence of a spirit world	*Science of Religion or Hierology.*

THE PAST OF HUMAN LIFE AND ACTIONS IS STUDIED.

1. In things antiquated or dug from the earth	*Archeology.*
2. In the decipherment of inscriptions	*Paleography.*
3. In the acts and sayings of the unlettered	*Folklore.*
4. In written records	*History.*

SCIENCES HELPFUL TO ANTHROPOLOGY.

To determine the material of art products	*Mineralogy.*
To fix the age of relics	*Geology.*
To studying the mutual effects of man and the earth on each other	*Geography.*
To determine man's place in nature and his acquaintance therewith	*Botany and Zoology.*

The expositions, museum, and cabinets of anthropology are arranged upon some classific concept, which must be fixed upon beforehand. These concepts give rise to schemes of administration for the purpose of finding a place for every object that has a name. The following are the principal concepts which guide the work of museum directors throughout the world:

1. Race or blood. Under this concept the aim is to have a separate room or place for each race or zoological type of mankind and to bring together in each space objects belonging to its race, so as to show how the members thereof live, move, and have their being.

2. The second concept is government and nationality, tribeship, or whatever corresponds thereto. In such a museum a space or an alcove is reserved for each tribe or nationality and the objects are arranged in the same way that they would be in the case of the races. Indeed, it is very difficult to separate in the mind race and nationality, though these two ideas have been necessarily in connection with each other.

3. The third concept, according to which anthropological material may be arranged, is language. There is a close connection between race and language and some ethnologists think that on the whole, and with certain easily explained exceptions, there is agreement. Under this concept space would be marked off for each language and all objects connected with the activities of the people who spoke that language would be assembled in that space. With primitive peoples this might be a safe plan to follow, but other considerations enter to offset this plan among the more civilized nations.

4. The fourth concept, according to which exhibition material may be arranged, is that of typical industries growing out of human wants, beginning with the desire for food, shelter and habitation, rest, and clothing, proceeding on through industrial æsthetic and social activities and ending with the concept of comparative religion. In such an exposition or museum the material could be arranged to show:

(*a*) Evolution or elaboration from simplicity to complicity or structure, as in tracing the latest breech-loading firearm from savage methods for wounding at a distance.

(*b*) To show the effect of environment and geographic influences upon objects belonging to a single art in the same grade of culture. A good example of this is the varied ways of carrying children practiced by North American savages, beginning with the fur hood of the Eskimo and passing through the cradle frames of the United States and Canada, ending with the naked babe borne upon the hip in the shawl of the mother.

(*c*) To show how the same ideas and forms of industrial products spring up among different races and tribes separated widely from one another.

In judging of the merits of any exhibit in the anthropological department of the World's Columbian Exposition it was necessary to hold the foregoing characteristics perpetually in mind. The marks upon which award was given were—

First. The material, its condition, rarity, and intrinsic value, regardless of the way in which it was administered.

Second. The arrangement, according to some preconceived classific concept. A very small and rather common lot of objects could be set up to teach some lesson or to explain some fact in anthropology and become thereby as precious as a large collection of materials brought from the most difficult situations.

Third. A mark of credit was due to intelligent labeling of collections in such a manner that in a moment of time the visitor would understand the idea involved. A prolix label, under the circumstances, would be almost as bad as no label at all. In the Exposition there were many collections that were models of administration in this regard.

Fourth. Illustrations, including photographs, prints, drawings, and paintings, showing at a glance just how the apparatus was used. In many cases this was a saving clause. Few visitors have had the pleasure of seeing oriental music performed, but when an instrument is accompanied by a photograph of a native playing upon it the situation is grasped at once.

Working upon the foregoing scheme it is possible for any judge or number of judges to arrive at a tolerably accurate idea of the merits of any collection or exhibit; at any rate these are the underlying prin-

ciples in accordance with which judgments were made, so far as the scheme could be carried out. I would say that in the beginning this plan was in the mind of the directors of the anthropological exhibit and the design has been to conform to the plan throughout. If any failures have been made it will not be attributed to the method, but to the scattered condition of the exhibits, the limited time at the disposal of many of the judges, and the lack of opportunity for consultation.

ARCHÆOLOGICAL EXHIBITS OF CENTRAL AMERICA AND MEXICO.

By ZELIA NUTTALL, *Judge.*

A notable feature of the World's Columbian Exposition has been the unprecedented assemblage of valuable and new archæological material from Central American ruins. Never before has there been such a fine and extensive exhibit of exact reproductions, plaster casts and photographs of the prehistoric monuments of Yucatan, Honduras, and Guatemala. To fully appreciate the value of these, it is necessary to realize, in the first instance, that they represent the highest development attained by the inhabitants of America, previous to its discovery, in the arts of architecture, sculpture, ornamentation, and writing.

These relics of a bygone civilization are disappearing with alarming rapidity, for year by year the trees, shrubs, and plants that cover the masses of ruined buildings, send out new shoots and roots that loosen the blocks of stone, and torrents of tropical rain carry the loosened fragments away.

To compare Catherwood's drawings of the principal edifices of Uxmal and Labnah with recent photographs is to realize the deplorable fact that within the next thirty years many of the finest sculptured façades now standing will be a shapeless mass of ruins. Efforts to save these from utter oblivion by means of photographs and reproductions can not therefore be overestimated, especially as explorations in these regions entail great risks, difficulties, and sacrifices.

The majority of these ruins are in inaccessible or malarious districts. The molds of the great monolithic stelas and altars of Copan, obtained by Messrs. Owens and Savile in the Honduras expedition, conducted by the Peabody Museum, had to be transported to the coast on mule back, the journey requiring a week.

In the performance of this admirable work Mr. Owens lost his life through fever in the beginning of this year, and his loss is an irreparable one to science and the institution he represented in so creditable a manner. In tribute to his memory let us first consider the results of his and of his collaborator Mr. Savile's labors in the field of exploration.

In the center of the anthropological building stands an impressive group formed by the casts of a number of the carved stelas and altars

of Copan, while on the walls of the aisles are many exact and interesting reproductions of fragments of architectural ornamentations and inscription. A complete set of fine photographs show these monuments in situ, while others illustrate the progress of excavations carried on not only at Copan, but at Chichen-Itza, Quirigua, Uxmal, and Labnah. This striking exhibit has been the means of awakening much interest in American archæology, the majority of people visiting the Exposition being totally unaware of the existence of such imposing prehistoric monuments on the American continent.

Through the small but valuable collection of fragments of sculpture from the above localities, sent by the Honduras Government, it was possible to study the native methods of working in stone from the originals.

Mr. A. P. Maudslay's truly magnificent set of large-sized photographs of the same ruins, which he was the first to study thoroughly, formed a most valuable contribution.

The ministry of public instruction of France exhibited a splendid set of M. Désiré Charnay's well-known casts of mural bas-reliefs from Palenque, Chichen-Itza, and Lorillard City (Yucatan), as well as of some antique statues and bas-reliefs from Mexico. In coloring a portion of a frieze from Chichen-Itza, on which he had found distinct traces of colors, M. Charnay made a novel and, I may add, successful experiment. There is no doubt but that the majority of aboriginal sculpture was brilliantly colored, and as color in itself was such an important factor in native pictography, it is a discouraging thought that its obliteration on existing monuments may debar us forever from deciphering these thoroughly.

In the open air in front of the anthropological building a noble group of ruins, tastefully surrounded and covered with appropriate plants, was set up in exact reproduction of the portions of the highly ornamented façades of such notable edifices as the house of nuns, house of the governor, serpent house at Uxmal, and the portal of a temple at Labnah. These were made from molds taken by Mr. J. J. Thompson, United States consul at Merida, Yucatan.

The Royal Museum of Berlin contributed eight fine casts of the celebrated bas-reliefs discovered at Santa Lucia Cazamalhuapa, Guatemala, by Habel, and described by its distinguished curator, Geheimrath Adolph Bastian.

In the Guatemala State building an extremely interesting set of casts was exhibited from the newly discovered ruins of Saxtanquiqui, in the province of Peten, near the Mexican frontier. The discovery of these important ruins is due to Mr. Federico Arthes, who, at the instance of Mr. Manuel Lemus, the public-spirited commissioner at the Columbian Exposition, was recently commissioned by the Guatemalan Government to explore the comparatively unknown province of Peten.

The majority of the bas-reliefs reproduced resemble those of Palenque, and represent a central figure in the act of making an offering, surrounded by calculiform inscriptions. One tablet differs, however, and exhibits a male figure only, carved in the more simple style observable in the Santa Lucia reliefs. The outlines and proportions are of unusual excellence. Unfortunately, the original upper portion of the slab is missing, with the neck and head of the individual represented.

Mr. Arthes reports the noteworthy fact that he found the missing portion next to the slab, but that the head and elaborate ornamentation surmounting it are of a totally different style of workmanship. I have examined photographs of both fragments, and they seem to indorse Mr. Arthes's statement that the upper one fits exactly on the lower. But the contrast between the severe and symmetrical outlines of the body and limbs and the grotesque and monstrous head surrounded by an unrecognizable mass of entangled decoration is startling, and the latter undoubtedly resembles grossly the Quirigua and Copan sculptures.

It would be of utmost importance to ascertain definitely whether the one fragment unmistakably pertains to the other, for if this be satisfactorily proven it will be possible to infer that the ornate and grotesque style of sculpture succeeded the plainer and more realistic in this region, and that the influence of the art that governed the Palenque reliefs was also felt here. At all events the variety of styles is in itself remarkable and significant and reveal how important it is that the extensive ruined cities in this region be thoroughly explored and investigated.

It is a satisfaction to report upon still more new and important archæological researches in Guatemala. Mr. Manual Elgueta, of Totonicapan, has recently discovered extensive ruins at Chalchitan, Pueblo Viejo, and Pichikil, in the province of Huehuetenango, and exhibits the interesting results of his excavations there. They consist of stone ornaments and implements and of pottery, some vessels being painted with figures and calculiform hieroglyphics. Although the collection is not a very large one, it is of particular importance, as, strangely enough, such relics are but rarely found in Central American ruins. This circumstance has led to the supposition that many of these ruined cities were abandoned at one time by their inhabitants, who carried away all their portable possessions. The Government of Guatemala also exhibit, with the fine topographical, hydrographical, and geological maps or charts recently made by Mr. Carlos Sapper, an interesting ethnological map showing the distribution of native tribes at the present day. Had the Mexican Government been able to carry out its original generous intention, its archæological exhibit at the Columbian Exposition would have been one of the finest and most important there. It was intended that the magnificent exhibit of

antiquities that excited so much admiration at the Madrid Historical American Exposition last year should be transferred to Chicago, but the transportation of the extensive collections from Mexico to Madrid occasioned such difficulties and delays that it was found impossible to undertake the gigantic task of repacking hundreds of cases at the close of Madrid Exposition, transporting them to Chicago, and exhibiting their contents on the prospective opening day. So the project was reluctantly abandoned, and the Mexican Government intrusted Dr. Antonio Peñafiel with the formation of a fresh representative exhibit, making a generous concession for it.

In view of the above circumstances, it would be unfair to criticise the result that fell short of the high standard taken at the Madrid Exposition. It is a pleasure, however, to mention the creditable collection sent by the Sociedad Científica of Toluca, containing some fine and unique specimens, proving the existence of an active center of archæological research. The government of the States of Puebla and Oaxaca sent interesting ethnological and archæological exhibits, and the ministry of public instruction exhibited important new material in the shape of casts of various bas-reliefs and a Zapotec calendar, etc., from Oaxaca, and of the magnificent publication "Antigüedades Mexicanas," published by the Junta Colombiana in commemoration of the quater-centenary. The States of Zacatecas and Hidalgo contributed representative illustrations of their antiquities and native types. It is a source of sincere regret that the State of Michoacan, that was widely known as a center of earnest scientific research a few years ago, has no representation at the Columbian Exposition. Indeed, the recent abolition of its museum, whose short but brilliant existence was due to the enlightened patriotism of the late governor of the State and the indefatigable zeal of its founder and director, Dr. Nicolas Leon, is a deplorable loss to scientists, who were gaining valuable information upon the antiquities and languages of the State from the Anales del Museo Michoacano.

The Republic of Costa Rica contributed an admirable archæological and ethnological exhibit worthy of a country whose bishop, Dr. Thiel, is a distinguished archæologist and whose minister plenipotentiary, Mr. Peralta, is a well-known historian and scholar. The exhibit was completely representative, containing a large number of fine and rare specimens, which were carefully classified and catalogued and most tastefully and artistically displayed. Special mention should be made of the fine paintings and maps that decorated the walls of the Costa Rica court and the valuable publications of Mr. Peralta which were exhibited.

The Government of Ecuador contributed a collection of archæological and ethnological objects, some of which were of special interest and value. It is regrettable that this fine collection, which also included specimens from Peru, Guatemala, and Mexico, was not

catalogued, and was so unfavorably exhibited in the Agricultural Building that it almost escaped notice.

To summarize: The Columbian Exposition marks an important era in Central American archæology, for it has brought together and placed before the public the finest and most complete collection of casts, reproductions, and photographs of the ruins of Central America that has ever been assembled. It is a pleasure to record that we owe the most valuable new material and the grandest, most impressive reproductions to the Honduras expedition.

Special recognition and gratitude is, therefore, due to Prof. F. Putnam, who was the originator and director of the noble enterprise, to the Department of Ethnology, to Mr. Dowditch and other patrons who generously supported it, and to the able explorers Messrs. Owen, Thompson, and Savile.

It is to be hoped that by awakening popular interest in the grand prehistoric ruins of Central America a fresh impulse may be given to archæological research in the United States, leading to further explorations and still greater results.

For though we can not arrest the hand of time as it slowly levels the great ruined temples and cities, we can earn the gratitude of posterity by preserving lasting records of their existence and appearance in this century.

THE ARCHÆOLOGY OF THE SAGINAW VALLEY, AS ILLUSTRATED AT THE WORLD'S COLUMBIAN EXPOSITION.

By HARLAN I. SMITH.

Although scarcely any archæological work has been attempted in the lower peninsula of Michigan, a small exhibit was made at the World's Columbian Exposition of materials and plans illustrating, in a measure, the archæology of a portion of the Saginaw Valley. The exhibit occupied 75 square feet of space, adjacent to that of Ontario, and consisted of a part of the results of the work of Mr. Edward S. Golson and myself in the territory indicated.

Along the shore of Saginaw Bay, and throughout all the territory draining into it, are found the remains of a primitive people. A quarry where some of these people obtained the stone for their pipes has been discovered, and it is very probable that there also exist ancient quarries where chert nodules of the Subcarboniferous series were formerly obtained, as this rock, which is the most frequent material of the chipped implements, outcrops in many places, not only along the bay shore, but also near the headwaters of the river. Workshops, village and camp sites, burial grounds, burial mounds, inclosures and embankments have been located, and near most of these have been found various pieces of chert nodules. The fractured nodule of raw material and the delicately finished implement are the extreme forms of these pieces, and besides their varied intermediate forms must be noted the vast amount of chips, refuse and "rejects." There have also been found in this limited territory nine caches, or deposits, of which records have been preserved. How many may have been accidentally disturbed or unearthed, and never reported, is not easy to estimate. But it is very probable that many more of these deposits of the treasures of a primitive people will be found, as the valley is more completely examined. The blades of seven, of the eight caches exhibited, were of a material closely resembling the nodular chert rock previously mentioned, samples of which may best be found at the Bay Port quarries, where it is now obtained for more modern purposes.

The cache not exhibited, being deposited in the Peabody Museum at Harvard University, contained blades of this material also. It was discovered by Mr. Golson, and was the first complete cache with a full label to be received by that museum. One of the caches contained

four forms of blades constituting a series from the nodule of raw material to a form requiring but a few more strokes to make of it a finished implement. The caches have all been found near navigable water, which was in direct communication with all the greater outcrops of chert-bearing rock.

Maps were exhibited, locating these caches and as far as possible the principal village sites, workshops, graves, burial places, mounds, etc., and showing the hydrographic basin of Saginaw Bay. The specimens were arranged with reference to these maps. All materials from one village site were placed together, so that the visitor could readily see what had been found at any single locality, and would know just what one might expect to find on a village site. The several village sites, workshops, etc., near Bay Port, and on North and Heisterman Islands, contributed an unusual proportion of rude and interesting material.

A large village site on the eastern banks of the Saginaw River, in the city of Saginaw, was represented by the usual village material; and from a village site and cemetery farther up the river were exhibited several pipes and stone beads, besides the usual material common to such places. Farther on up the river, at the junction of the Shiawassee and Tittabawassee rivers, there was a very large village. This place was inhabited even down into historic times, and then by the Chippewas, early French settlers, and house-boat fishermen in the order mentioned. Traditions of the Chippewas state that in early times another people had a great village here, that the neighboring tribes united in a war of extermination and destroyed the village, burying the unfortunate inhabitants in two large conical mounds. It is interesting to note that such mounds exist on the western side of the village site and may be those referred to in the tradition. It was at this point that Mr. Golson discovered two of the caches while cooperating with the author in a preliminary examination of the village.

On the banks of the Tittabawassee River, several miles above its junction with the Saginaw, several of the caches were found, in which were some beautifully chipped chert knives over 7 inches in length. Here, too, was a large village site, a workshop, and a burial mound. From this locality were exhibited, besides the usual material, a number of copper objects and copper beads. The string from the beads had been partly preserved by the copper salts. In this manner many of the ancient village sites of the valley were represented, but mention of them all can not be made at this time. A pottery urn 167 (restored) originally in the collection of the late Judge Barter, was exhibited, which is now 1 foot and 8 inches in height by 3 feet 9 inches in circumference, and must originally have been over 2 feet in height. This urn, found inverted over the head of a skeleton at a

village site and burial place on the bluff at the bend of the Cass river, 6 miles above Saginaw, is unusually well preserved for so large a pot, and one from a locality where nature does not smile upon archæologic specimens as she does in Colorado and Peru, but rather sends frost and moisture among the other elements to do them damage.

Two crania, each presenting certain anatomical peculiarities, were the only specimens in that line exhibited. Although many skeletons have been discovered by workmen in this region, practically all were ruthlessly destroyed and none have been saved for science in their entirety. The materials obtained from the Ayres mound, together with a photograph of the mound, which was of the typical conical form, and contained strata of ashes, burned clay, etc., were also shown.

A mass of specimens from various parts of the valley, which could not be classed as from any particular village site, but was thought to be more properly termed general surface material, was arranged upon the basis of form. In this series the chipped implements were placed together, then the celts, grooved axes, ceremonial slate objects, etc.

The endeavor throughout the arrangement of the entire case was to give the best possible opportunity to study the specimens, to show a use for such material, and for careful exploration, and with the aid of maps and photographs to convey to the visitor some information respecting the archæologic resources of the Saginaw Valley.

A CAVE-BEAR SKULL EXHIBITED BY DR. WANKEL, OF AUSTRIA.

By Prof. THOMAS WILSON.

The exhibit is made up as follows: (1) A portion of the skull of a cave bear, showing a healed wound; (2) a piece of chipped stone, believed by Dr. Wankel to be a portion of the spearhead with which the bear was struck; (3) a complete cranium of a cave bear, a jaw, and other fragments; (4) several chipped stones of the same kind as the supposed spearhead; (5) (6) pictoral illustrations; (7) a pamphlet, in which the discovery of the pathological *crista sagittalis* is narrated.

In the pamphlet, "Die prähistorische Jagd in Mähren," Dr. Wankel states—

(1) That the *crista sagittalis* was found by him in the upper stratum of one of the diluvial caverns of Sloup, Morovia, many years ago.

(2) That the fragment of stone was found some days later by two peasants who were working in the caverns.

(3) That he (Dr. Wankel) believes that the cavern was occupied by cave bears as a dwelling place for a long period.

(4) That no objects of human workmanship, except the single chipped stone, were found in the cavern.

He believes that the chipped stone is a fragment of a spearhead, that the spear to which it belonged was thrust at the cave bear by a prehistoric hunter and caused the wound shown by the skull. He regards the skull and implement taken together as proving that man lived synchronously in Moravia with the cave bear, and hunted it.

The results of my investigation I may state as follows: I am satisfied that the piece of bone in question is a portion of the skull of a cave bear, and that it shows evidences of a healed wound which may have been caused originally by a spear thrust. The piece of stone appears to me to have been worked by man, though on this point I do not intend to offer an expert opinion.

Regarding Dr. Wankel's conclusions, I feel obliged to hold that while there is great probability that they are correct he has not established them beyond all question. This view forces itself upon me because (1) the stone was not found in the skull. It may never have been there, and the injury may have been caused in some other way. (As the specimens were in a case, I was unable to determine whether

the stone fitted accurately into the pit in the crest of the skull. If it does, I should, of course, consider the fact of its being the immediate cause of the wound as demonstrated. If it does not fit quite accurately, the probability of its being formerly lodged there is not, however, greatly weakened, as is in healing new matter would probably be deposited in the wound, changing its form, and raising the stone from its original position). (2) Dr. Wankel did not find the stone in position himself, but it was handed to him, as already stated, by two workmen some days after the skull was exhumed. They could not state whether it lay close to the skull or in the immediate vicinity of the same. (See pamphlet, page 64.) It may never have been in the cavern. (The statement should be made, however, that Dr. Wankel knew the workmen by name and appears to have had confidence in them). Finally (3), the stone does not appear to me to be the broken fragment of a spearhead of considerable size, as represented in Plate VI accompanying his narrative. It does not show at the larger end the straight edge displayed by other fragments of the same kind of stone which are in the collection. This is not of serious moment, however, as the stone may be a complete implement of small size.

MEMORANDA.—After Mr. True, the judge in the aforesaid case, had left the Exposition, I became interested to know whether the piece of flint would fit the wound in the skull; therefore obtained the necessary authority and opened the case and tried the piece of flint in the wound, which it fit with great exactness.—T. W.

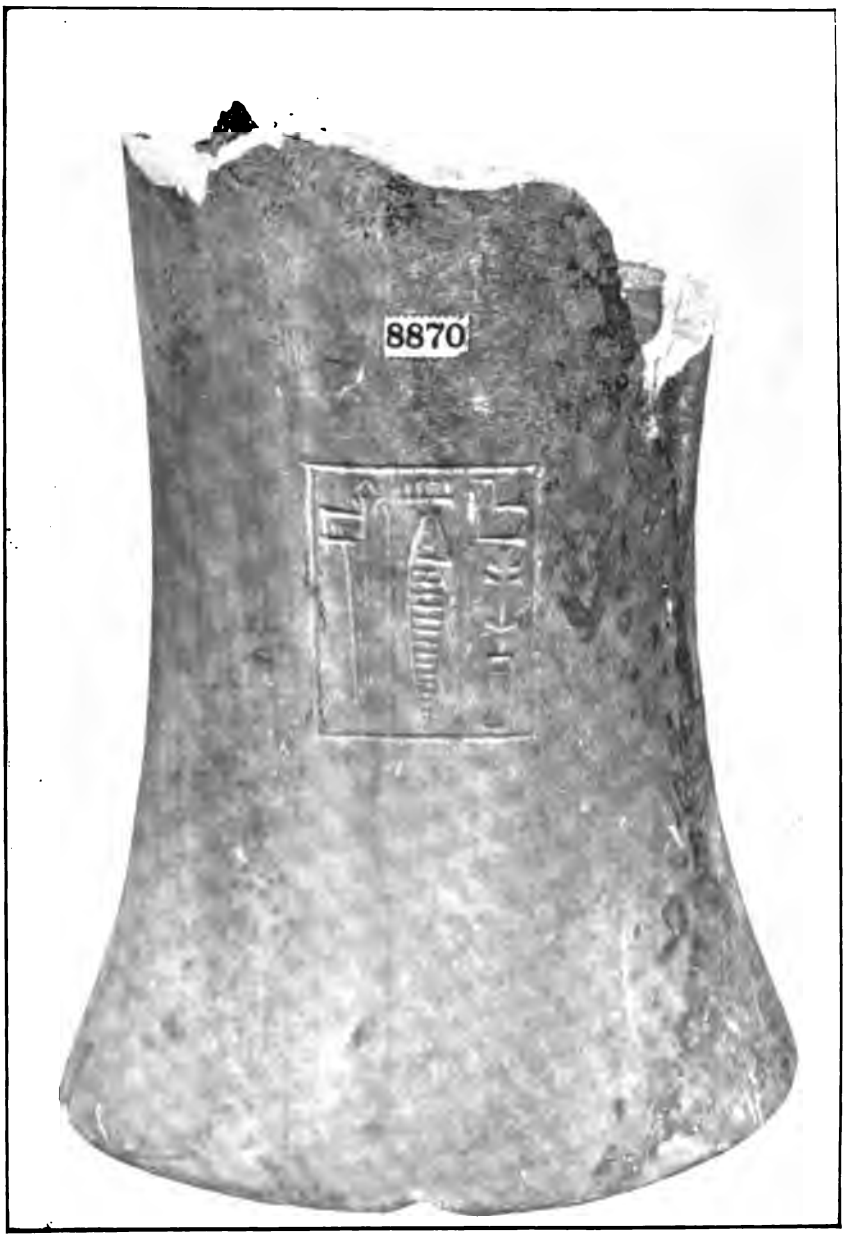


FIG. 1.—WHITE MARBLE VASE OF ÂLUSHARSHID, KING OF KISH. NIPPUR. CIRCA 3820 B. C. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

UofM

EGYPT, BABYLONIA, AND GREECE.

By Mrs. Sara Y. Stevenson.

The exhibits in these archæological fields at the World's Columbian Exposition were of an important character, and marked a decided step in the progress of the study of these branches in this country. Most of them represented serious scientific work, being as a general rule well classified and displayed, and, in one important instance, the material collected was the result of an extensive exploring expedition, the first undertaken by American scholars under the auspices of an American university.

BABYLONIA.

Babylonian archæology was principally represented by some of the most valuable results of the scientific expedition sent, in 1888, under the auspices of the University of Pennsylvania to explore the site of ancient Nippur on the lower Euphrates. The explorers, under the leadership of Dr. J. P. Peters, were fortunate in recovering a large number of fragments, bearing historical inscriptions, in which not less than forty-five of the ancient kings are mentioned by name, while other valuable data, spanning over 3,500 years of Babylonian history, have been collected. Many of these original fragments—bricks, stamps, door sockets, stone vases, etc.—were exhibited by the Babylonian section of the department of archæology and paleontology of the University of Pennsylvania. Most interesting among them were those referring to six ancient monarchs whose existence was hitherto unrecorded, and whose inscriptions were therefore thus placed for the first time before the learned public. One of these, Urumush—read Âlusharshid (fig. 1), by Dr. Hermann V. Hilprecht, professor of Assyriology at the University of Pennsylvania, and a member of the exploring party, to whom the publication of these texts has been intrusted—probably dates back to the earliest period of the Babylonian record. He must take his place by the side of Sargon I, and his son, Naram-Sin, at the very dawn of history, and like them, he seems to have been a mighty conqueror, as his conquests of Elam and Barasse are mentioned in the texts. Besides this important addition to the scant knowledge hitherto possessed of this remote period, many new facts bearing upon the history of kings already known have been brought to light. Three door sockets bearing inscriptions of Sargon I

(3800 B. C.), one of which gives the hitherto unknown name of that monarch's father, Itti-Bêl, as well as other inscriptions of his and of Naram-Sin, may be cited as examples. To the list of monarchs of the Isin dynasty has been added one king, Bur-Sin I (fig. 2), and information of some historical value with regard to the reigns of Ur-Ninib and of Ishme-Dagan has been obtained from tablets of their reign. Two kings of the Kassite dynasty (B. C. 1440–1140), whose names are read Gande and Kadashman-Turgu, have been added. And an inscribed stone purchased by the expedition has also yielded a new king, Bel-Nadin-Aplu (fig. 3), belonging to the Pashe dynasty (1140–1000 B. C). These inscriptions were accompanied by the first volume of the published texts ("Old Babylonian Inscriptions, Chiefly from Nippur," by Hermann V. Hilprecht, 1893). Many of these texts are likely to shed light not only upon many historical and chronological problems, but upon the uncertain and disputed reading of many names and words. Indeed, it would be difficult to overestimate the value of the contribution to science represented by this exhibit.

To this series, but of a later date (about 700–1400 A. D.), also belonged a collection of about 125 to 150 terra cotta bowls, exhumed from the ruins of Nippur. They bear inscriptions in black ink running spirally around the inside of the bowls. Not infrequently a few short lines also appear on the outside. The languages used are Hebrew, Mandaic, Syriac, mostly Arabic (written in Hebrew characters). Often the inscription is accompanied by cabalistic signs, or the rude picture of one or more demons. They were used as charms against evil spirits who were supposed to cause hallucinations and sicknesses, and to exercise noxious influences on the occupations of daily life. They were often hung on cords in the houses and placed in the coffins of the dead. (C. 700–1400 A. D. Fig. 4.)

With the series brought from Nippur were displayed a number of fine museum pieces, cylinders, contract tablets, gold ornaments, and other interesting objects. Among these the large and admirably preserved cylinder of Nebuchadnezzar II and a fine alabaster vase of the time of Xerxes, bearing a quadruple inscription in Egyptian, Babylonian, Median, and Persian, are deserving of special mention.

Another fine specimen of cuneiform writing was exhibited by Mr. Dikran G. Kelekian (fig. 5).

This was a remarkably preserved alabaster tablet bearing an inscription in old Assyrian cuneiform of the reign of King Rammân Nirâri I (B. C. 1325), and giving the name of the monarch's father and grandfather. In it the king mentions different campaigns undertaken by himself, and ends with the usual imprecations against the destroyer or defacer of his monument. This is another edition, as it were, of the inscription obtained by George Smith at Kal'ah Shergat, which is published in the fourth volume of the British Museum publication (pls.

FIG. 2.—BRICK OF BÛR-SIN I, OF THE DYNASTY OF TSIN. FROM THE TEMPLE OF BÊL. NIPPUR. CIRCA 2550 B. C. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

Mau

FIG. 3.—IN MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

Nau

FIG. 4.—TERRA COTTA BOWL BEARING INSCRIPTION IN HEBREW CHARACTERS, WITH DEMON IN THE CENTER. NIPPUR. CIRCA A. D. 1000. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

Mau

FIG. 5.—ALABASTER TABLET BEARING AN INSCRIPTION IN ARCHAIC ASSYRIAN CHARACTERS OF KING RAMMÂN NIRÂRI I. CIRCA 1325 B. C. DITHRAN KELEKIAN (EXHIBITOR).

Non Nou

44, 45). The division of the lines is different, however, and the text not only is more perfect but contains numerous and important variants useful in clearing up obscurities. Dr. Morris Jastrow, jr., to whom the tablet was submitted by me, has also pointed out the interesting fact that it is dated five days later than the copy in the British Museum. It is therefore likely that the king had several copies of his commemorative tablet prepared for deposit in various places, either in different parts of his palace, or in different edifices.

As George Smith reported having seen other fragments and inscriptions of Rammân-Nirâri I at Kal'ah Shergat, the presence of this little monument is easily accounted for. The transliterated text has been published by Mr. V. Scheil in a recent number of the Recueil de Travaux, XV, 3–4, p. 108. And Professor Jules Oppert has lately read a paper upon this tablet before the "Académie des Inscriptions" (June 9 and August 25, 1893), as the most ancient inscription of an Assyrian king, in which he gives a full translation of it.

EGYPT AND GREECE.

The Egyptian section of the museum of archæology and palæontology of the University of Pennsylvania exhibited collections representing some of the principal results of the explorations conducted by Mr. W. M. Flinders-Petrie in Egypt during the past ten years.

A portion of the material displayed was obtained through the Egyptian exploration fund. This principally consisted of fine potsherds of polychrome incised ware (figs. 6 and 7) mostly found in the temene of Apollo and Aphrodite at Naucratis (Tel-Nebireh), by means of which may be traced not only certain interesting facts bearing upon the history of ceramics, but the evolution of many decorative forms handed down to us by the Greeks. Also many objects, molds for scarabs, amulets, etc., from the factory that supplied the commerce of the Greek colony with the Mediterranean peoples, and which, after being manufactured at Naucratis, found their way to more or less distant points.

FIG. 6.—Potsherd from Naucratis. In the museum of the University of Pennsylvania. Phrygian lion.

From Tel-Defenneh (Daphnæ, eastern Delta) were exhibited a series of bronze and iron implements found upon the site of the camp of Greek mercenaries employed by Psammetichus I in his struggle against the dodecarchy (B. C., seventh century). And the fine painted potsherds of polychrome incised ware recovered among the ruins of Daphnæ (figs. 8 and 9) complete the story told by those of Naucratis, as to the influence of the Greek artist-potters of the Delta upon the development of ceramics in the seventh and sixth centuries B. C. The more important

portion of the exhibit, however, was sent directly to the museum of the University of Pennsylvania by Mr. Flinders-Petrie, and illustrates his discoveries in the Fayûm (1889–90) at Medûm (1891) and at El-Amarna (1892).

From the Fayûm were displayed numerous objects, principally from

FIG. 7.—Naucratis potsherd. In the museum of the University of Pennsylvania. Oriental design.

Kahun, a town which seems to have been abandoned after the twelfth dynasty (about B. C. 2600). Among these are wooden tops, tip-cats, spindles, combs, etc.; a series of copper and weak bronze tools and some flint blades found associated with them, all of which are suggestive of the work-a-day life of the people at that remote perod. Somei

FIG. 8.—Daphnæ potsherd. Museum of the University of Pennsylvania. Assyrian sacred tree. Seventh century B. C.

fragments of fine diorite vessels, upon which can be detected the tool marks of the turning lathe, were of peculiar interest as illustrative of the industrial handling of hard stone in ancient times. And to complete this object lesson there were exhibited with these some remarkable specimens of tubular drilling in ancient Egypt; three alabaster

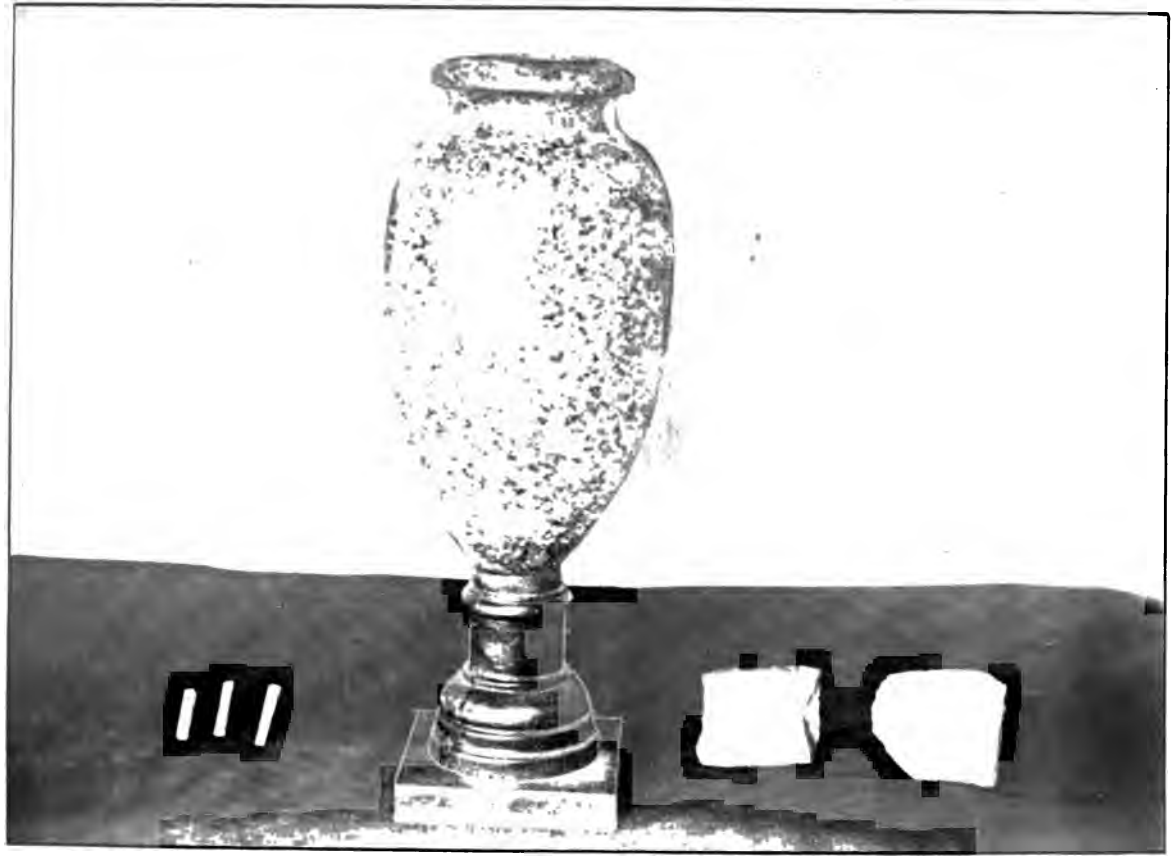


FIG. 10.—FRAGMENTS OF DIORITE VESSELS, SHOWING TOOL MARKS OF TURNING LATHE.—ALABASTER CORES, SHOWING MARKS OF TUBULAR DRILL.—SYENITE VASE, SHOWING MARKS OF TUBULAR DRILL AND ROUGH BASE OF CORE BROKEN OFF AT THE BOTTOM

Not to be taken away

FIG. 11.—"CARTONNAGE" AND GREEK BUSINESS LETTER, FROM THE FAMOUS "FIND" OF GREEK PAPYRI. GUROB. PETRIE EXPLORATION, 1889-90.
MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

FIG. 12.—HEAD OF A LIONESS, SHOWING ASIATIC INFLUENCE. GUROB. PETRIE EXPLORATION, 1889–90. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

cores found at Naucratis upon which the ridges of the tool are plainly visible, and a superb example of similar work in the shape of a fine vase of syenite found at Ghizeh and now the property of Mr. John Struthers, of Philadelphia, in which not only the tool marks of the tubular drill are clearly discernible, but at the bottom of which the base of the broken core remains rough, as it was knocked out in ancient times (fig. 10).

From Illahun, and of the same date, a series of painted limestone fragments from the sepulchral shrine of the Princess Nefer-Atum, daughter of Usertesen II, was exhibited to illustrate the various parts of such a structure, with their decorative details, at one of the best periods of Egyptian art. With them was also shown a fine limestone statue of a seated man.

From Gurob, a Greek business letter of the reign of Ptolemy Epiphanes (fig. 11), forming part of the celebrated find of Greek

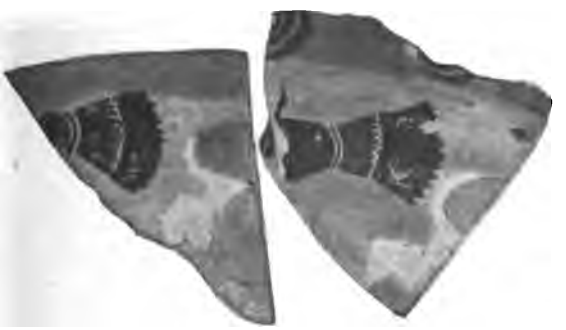


FIG. 9.—Daphnæ potsherds. Museum of the University of Pennsylvania. Archaic form of Harpy. Seventh century B. C.

papyrii discovered by Mr. Flinders Petrie in 1889, and an unopened cartonnage, composed of eight thicknesses of inscribed papyrus, were interesting specimens.

Of the same site, but dating back to the eighteenth and nineteenth dynasties, besides a large number of objects in daily use, including a series of bronze implements, shown with flint tools found associated with them, was exhibited a block of limestone bas-relief, once a part of a scene of the adoration of the sun disk by Khu-en-Aten (B. C. 1450) in which the disk is depicted, in true Mesopotamian style, as a rosette. A fine painted limestone head of a lion (fig. 12), the execution of which also betrays Asiatic influence, is likewise strongly suggestive of the cosmopolitanism of a period when Babylonian scribes attached to the court of this king at El-Amarna, conducted with Syria and Mesopotamia, the extensive correspondence, part of which was recovered in 1887.

This cosmopolitanism was further illustrated at Chicago by the results of Mr. Flinders Petrie's last year's work (1892) at El-Amarna.

Here, in the refuse heap of the palace of Khu-en-Aten, he found a large quantity of Ægean pottery and glass. The fragments of five different types of Ægean vases were exhibited in the collection, notably the false-necked variety, so typical of this class of vessels (fig. 13), and a number of fragments of Ægean variegated glass completed the evidence displayed of the close intercourse existing between Egypt and the Mediterranean peoples at a time preceding the opening of Greek history.

FIG. 13.—Types represented by fragments of Ægean pottery found at Tel-el-Amarna by Mr. Flinders Petrie, 1892.

The collection from this site included other objects of great interest, numerous fragments of columns and capitals, sculptured stone and alabaster bearing the names and titles of King Khu-en-Aten and of his Queen Nefertiti (fig. 14), or parts of the ever-repeated scene of the adoration of the disk, giving an idea of the architecture of the period, and a cast of the death mask of the monarch found by the fortunate explorer among débris of ushabtis (fig. 15), etc., left in a chamber of the palace, probably by the artists who carved his funeral statues, as well as an original unfinished bas-relief portrait of the living king (fig. 16), are worthy of special mention. But one of the most interesting features of this important collection was a full series illustrating certain branches of the glass industry in the fifteenth century B. C., from the fragments of the pottery furnace (fig. 17), with the frit still adhering, lumps of all shades of coloring clays and quartz pebbles which were melted and used for silicate, to the rough lumps, the drawn, flattened or tubular strips of colored glass and the finished beads and bugles. Completing the series were 70 molds for casting ornaments and amulets exhibited with the small objects themselves that were cast from them, many of which could be fitted into them. Some of these are inscribed with the cartouches of Kings Khu-en-Aten, Tut-ankh-

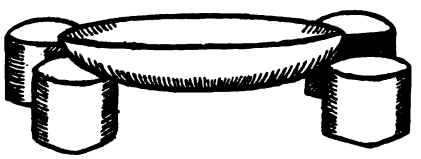


FIG. 17.—Fragments of pottery furnace reconstructed by Mr. Flinders Petrie. El-Amarna, Petrie exploration, 1892, Museum of the University of Pennsylvania.

FIG. 14.—FRAGMENTS SHOWING FACE, FIGURE, NAMES. AND TITLES OF QUEEN NOFERTITI. EL AMARNA. PETRIE EXPLORATION, 1892. MUSEUM OF THE UNIVERSITY OF PENNSYLANIA.

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FIG. 15.—CAST OF MASK OF KING KHU-EN-ATEN (CIRCA 1450 B. C.) ORIGINAL IN GHIZEH MUSEUM. EL AMARNA. PETRIE EXPLORATION, 1892. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

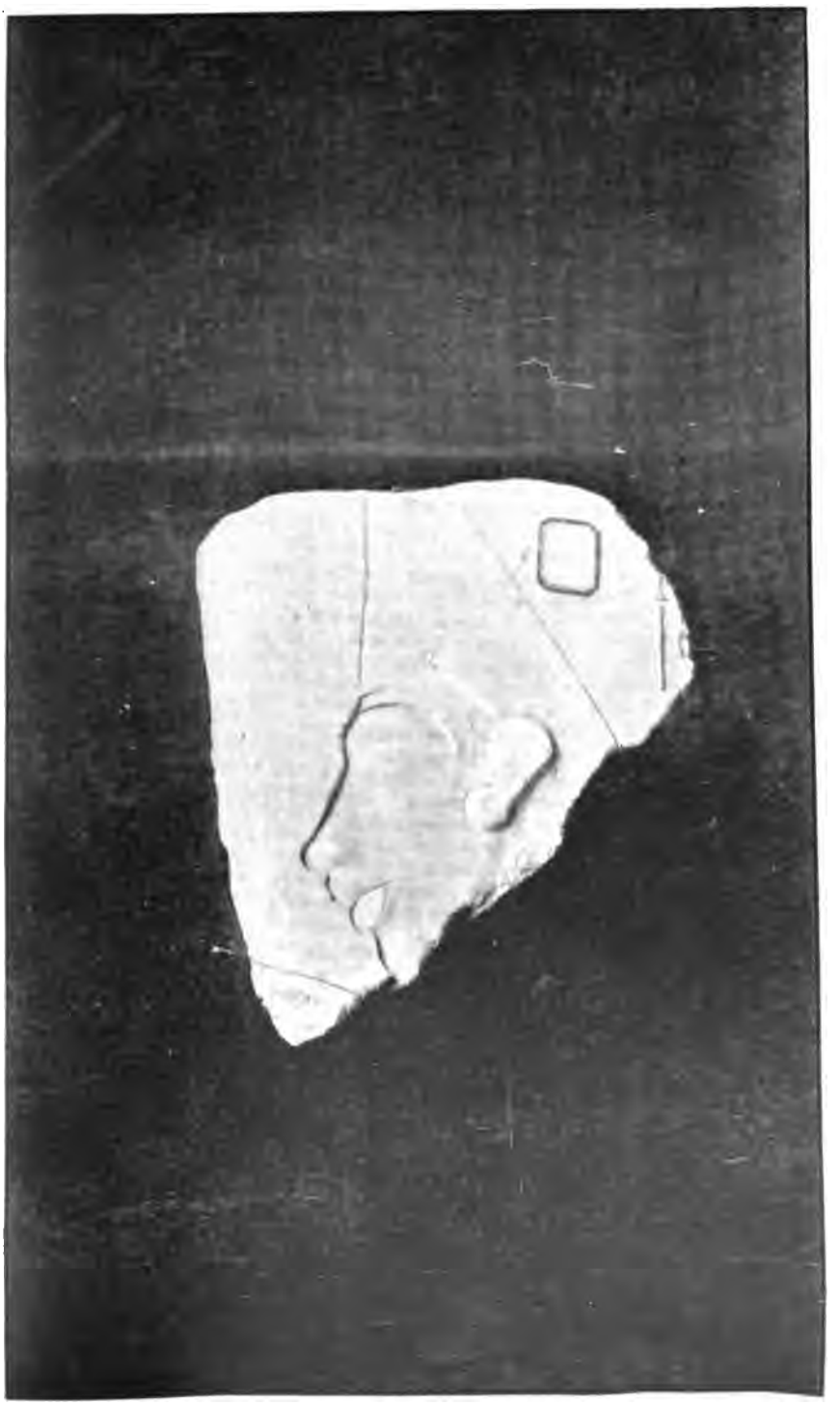

FIG. 16.—UNFINISHED BAS-RELIEF PORTRAIT OF KING KHU-EN-ATEN. EL AMARNA. PETRIE EXPLORATION, 1892. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

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FIG. 18.—GLASS FACTORY. EL AMARNA. PETRIE EXPLORATION, 1892. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

FIG. 19.—SELECTION FROM A NUMEROUS COLLECTION, ILLUSTRATING THE EGYPTIAN PANTHEON. MR. ARMAND DE POTTER.

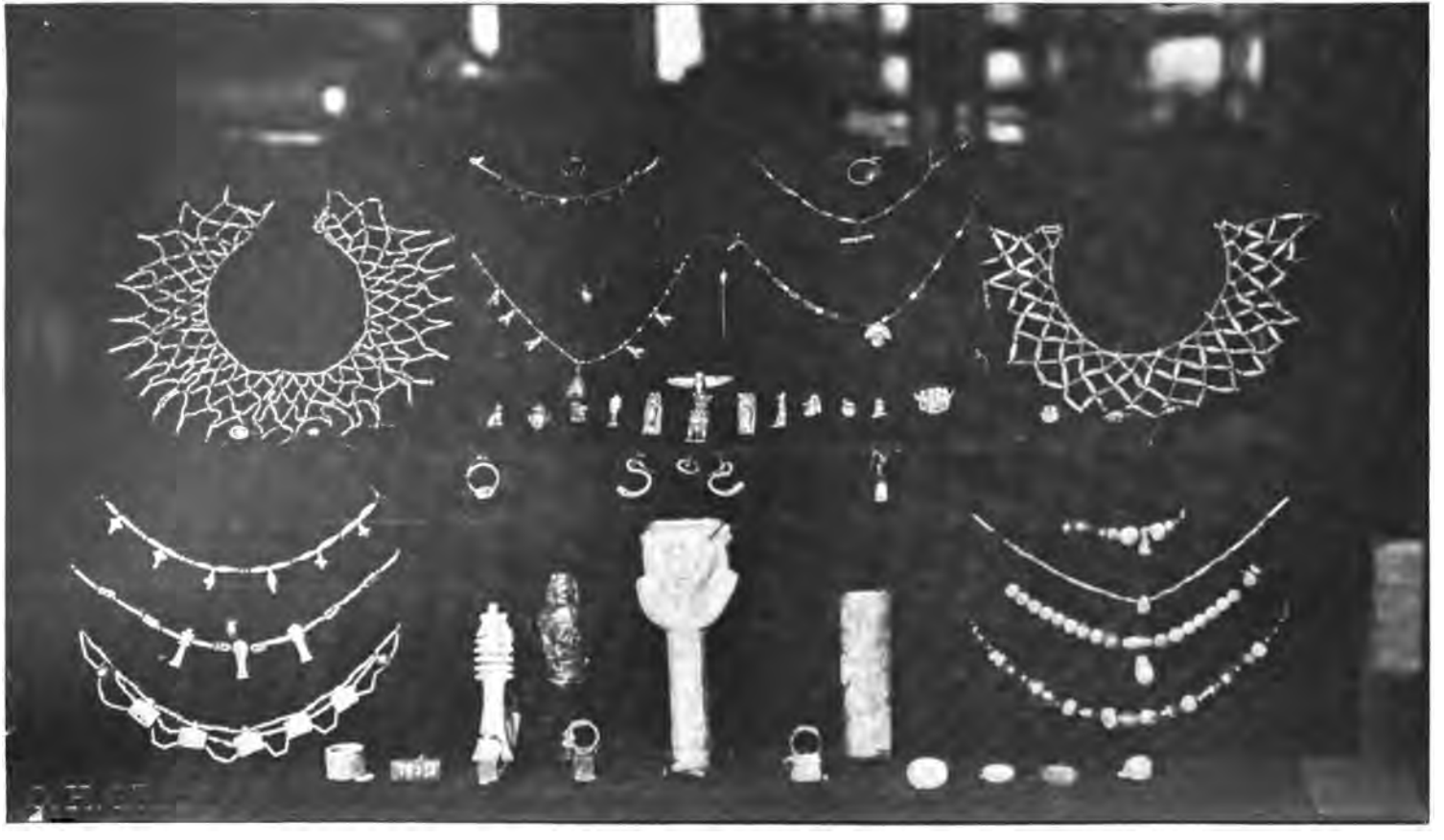

FIG. 20 —SELECTION FROM A NUMEROUS COLLECTION OF AMULETS AND JEWELS. AMONG THESE ARE GOLD JEWELS FROM THE GREAT "FIND" OF ROYAL MUMMIES AT DEIR-EL-BAHARI. MR. ARMAND DE POTTER.

FIG. 21.—SERIES OF CLAY AND STONE IDOLS, RANGING FROM THE THIRD MILLENIUM B. C. TO ABOUT THE SIXTH CENTURY B. C., SHOWING ARTISTIC EVOLUTION OF THE NATURE-GODDESS. CYPRUS. RICHTER COLLECTION. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

Amon, and Ra-s-aa Ka-Rhepru, and accurately date the whole series (fig. 18).

The extreme interest which has attached to Mr. Petrie's late discoveries and the bearing which they have upon the ethnology of Egypt and the history of its early intercourse with the Mediterranean peoples makes these collections of special importance.

Egypt was further represented by a charming collection of bronze and porcelain glaze statuettes, exhibited by Mr. Armand de Potter, illustrating the Egyptian pantheon. Besides exquisite specimens of bronze and porcelain-glaze statuettes of gods and goddesses (fig. 19), several of which were possessed of artistic merit, it included a series of amulets and jewels of stone, gold, and porcelain glaze (fig. 20), a number of scarabæi, and some funeral objects, etc., the whole forming a very representative, if incomplete, series, bearing upon the subject which it was the purpose of the owner to present to the public.

The Mediterranean section of the department of archæology of the University of Pennsylvania exhibited a collection of Cypriote antiquities obtained from the explorer, Dr. Max Ohnefalsch Richter. Hagia-Paraskevi is the site from which most of the oldest objects of the copper-bronze age were derived, but the collection included also objects from Tamassos, Idalion, Amathos, etc. The hand-made pottery of polished red ware, decorated with incised geometrical designs, belongs to the oldest strata, and many of the pieces recovered show marked similarity with those found in the oldest strata at Hissarlik by Dr. Schliemann. The earliest among these date, according to Dr. Richter, from the third and fourth millennium B. C. With the second millennium B. C. true bronze appears in Cyprus, and with it comes a gradual modification of the pottery; contact with Egypt, under the new empire, begins to appear, and the influence of the so-called Mycenæ culture betrays itself in the introduction of varnished pottery and (about 1300 or 1200 B. C.) of the potter's wheel. These various periods were illustrated in the collection by well-chosen specimens of vases, copper and weak bronze, and true bronze weapons and implements, which mark the development of Cypriote civilization down to the Græco-Phœnician epoch, when iron was in use.

A very complete series of whorls, among which many recall the types found by Schliemann at Hissarlik and Mycenae, formed an interesting part of the collection, which also contained a number of curious clay and stone objects. The most important feature was, however, a series of clay idols (fig. 21), the oldest of which may go back to the third millennium B. C., when, in Cyprus, the nature goddess was worshiped in groves, and when, at the dawn of art, she was represented by a shapeless board-like clay fetish showing the faintest trace of female attributes, which, in time gradually developed into a crude but distinct female form. This advance was illustrated in the series

by a clay figure with a round, column-like body surmounted with a female head adorned with a necklace, and holding a tympanon, dating from about the tenth century B. C., found in the temenos of Astarte, and representing the goddess. The series ended with fragments of stone representations of Aphrodite and of Artemis, found, respectively, in the shrines of these goddesses, and dated about the seventh and sixth centuries B. C.

A fine series of Etruscan and other Italian pottery, including some excellent specimens of Bucchero ware, was exhibited by Dr. Robert H. Lamborn (fig. 22). Among the notable objects in the collection was a large bronze ring, of which duplicates have found their way into other collections without its use having been satisfactorily explained. Dr. Lamborn, however, when in Rome, purchased a fine potsherd of polychrome painted ware representing a processional scene, in which a party of musicians play a part, one of whom holds in his hand this object. This interesting fragment was displayed with the specimen, to which it lent additional importance.

With the collection was also shown a series of old Roman glass (fig. 23), in which were included some rare fragments of the same manufacture as the celebrated Portland vase in the British Museum.

The collection of 75 Greek portrait panels found in the Fayûm in Egypt, and exhibited by Mr. Theodor Graf, was one of the most important contributions to the department of archæology. As a series the collection is unique, and the facilities which were offered to the student of ancient art by the bringing together of so large a number of specimens can not be overestimated.

Prior to the "finds" of Mr. Petrie at Hawara, and to those of Mr. Graf's agents at Rubayat-Kerke, a locality some 14 miles distant from the site of Arsinoë (ancient Crocodilopolis), only a few examples had found their way into European museums, the largest collection being that of the Berlin Museum, composed of 24 specimens found at Hawara. Moreover, only a few and generally poor examples of ancient easel painting had survived.

The discovery of these portrait panels therefore revealed to the learned world the various technical methods employed by the ancients and added a chapter to the history of ancient art. The portraits are generally painted on thin boards of cedar or sycamore, upon which was laid a priming of distemper, then a grounding, lead color for the draperies, flesh color for the face. After this the surface was worked sometimes in a pasty state, sometimes free flowing. The broad surfaces of flesh were often laid on in zigzag strokes just joining each other, while the drapery was done in flowing way with the brush. Both the cestrum and the brush were used.

These details are revealed by an unfinished portrait now in the South-Kensington Museum, which was turned and reused (see W. M.

FIG. 22.—"BUCCHERO NERO" AND OTHER ITALIAN WARE—BRONZE RING AND FRAGMENT OF POLYCHROME PAINTED WARE WITH PROCESSIONAL SCENE, SHOWING USE OF THE RING. LAMBORN COLLECTION.

Main

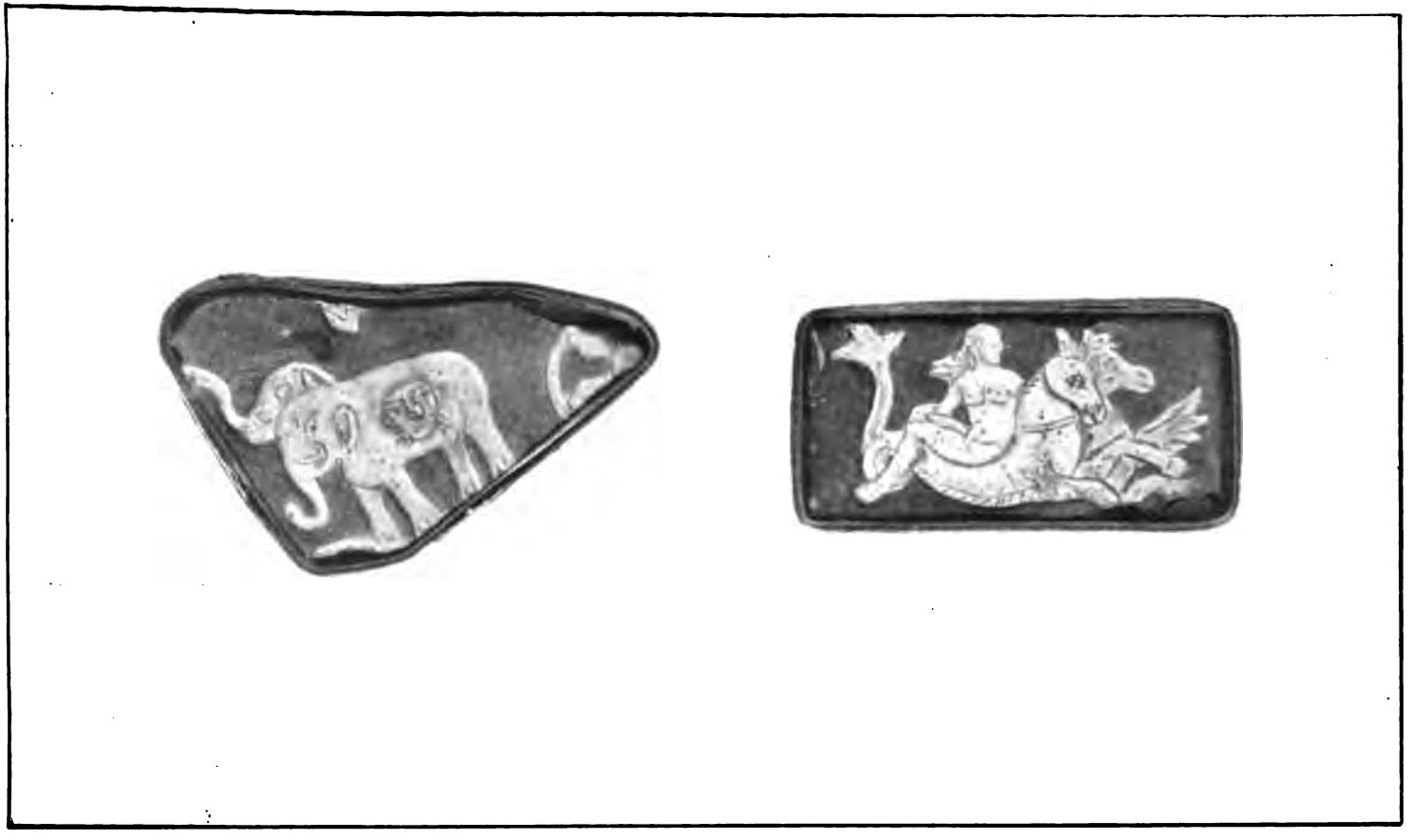

FIG. 23.—SPECIMENS OF ROMAN GLASS. LAMBORN COLLECTION.

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FIG. 24.—ENCAUSTIC PORTRAIT, FROM THE ROMAN NEKROPOLIS OF HAWARA (FAYÛM), A. D. 200. FLINDERS PETRIE EXPLORATION, 1889. MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA.

Flinders-Petrie, Hawara, etc., p. 18). There is every probability that this technique originated in Egypt, where the heat of the sun minimized the difficulties of the process. Pliny claims the invention of encaustic painting for Polygnotus of Thasos, but to Egypt and Alexandria the names of many of the celebrated encaustic painters of antiquity may be traced, and wax was used to preserve painting in Egypt as early as the eighteenth dynasty.

Some specimens in the Graf collection are painted in distemper; in others there occurs a blending of the two processes, used with very good effect.

The oldest portrait in the series bears a Phœnician inscription—Baal Adar—upon its back, which has been pronounced by Professor Euting, of Strasbourg, upon palæographical grounds, to be of the fourth century B. C. As a rule they seem to date from about the beginning of the Christian era, most of them are of the second century after Christ, although according to Mr. Flinders-Petrie some may be as late as the reign of Constantine (337 A. D.). None are likely to be later than the edict of Theodosius, A. D. 391. In the oldest one of these portraits the Egyptian influence is especially strong. The eyelids and eyebrows are heavily marked and the defunct is represented wearing the convential lock of youth. In some of the best examples, in which the Greek artistic sense is strongest, the eyes are treated naturally and among them are works of such artistic merit as to have excited the unqualified admiration of some of our best modern artists. But these portraits, besides throwing light upon the history of art, have also an ethnographic importance. They forcibly bring before us the fact that Hellenized Egypt was not confined to Alexandria and the Greek settlement in the Delta, and that in the Fayûm and other parts of Egypt there lived Greeks of rank and wealth who had so far become Egyptianized as to adopt the funeral usages of the inhabitants of the Nile Valley, and who, with a certain percentage of Semitic stock, formed a mixed population, the different elements which are clearly represented in the collection.

The custom of placing the portrait of the deceased over the face of his mummified remains was a modification by the Greeks of the Egyptian mummiform coffins, on which the human head was always reproduced, though it might be in a conventional manner. Mr. Flinders-Petrie found some at Hawara inserted in a cartonnage case, and held in place by a thickly gilt frame. One of these of Roman times (A. D. 200), formed a part of the collection from that site exhibited by the Museum of the University of Pennsylvania (fig. 24).

The other manner of setting these portrait frames was illustrated by No. 94 of the Graf collection, in which the mummified remains are swathed in skillfully crossed bands of linen forming accurate squares, after the manner in which the Egyptians were wont to arrange the

mummified remains of their sacred animals or birds. Here the panel is fastened by mere strips of linen which are held in place by the application of asphaltum or resinous glue.

Dr. Georg Ebers, who has carefully studied the Graf collection, has made the suggestion that these portraits were probably painted during the lifetime of the individual, being originally used as a wall decoration. Easel painting was known to the Alexandrian artists; and Heydemann has pointed out that the Epicureans were in the habit of purchasing tabulæ, or picture tablets, of their master (Cic., De Fin., No. 1), and Christians, of Jesus Christ and of the Apostles, Peter and Paul (Euseb., Hist. Ecc., VII, 18). As some of these portraits show traces of stucco and of nails, the probability seems a strong one that these were detached from the wall in which they had been inserted. But Dr. Ebers has very properly pointed out that a large number of them show no such traces, and are, moreover, of very inferior workmanship, and that they may, therefore, be regarded as crude copies of portraits painted in the lifetime of the deceased made especially for funeral purposes. The observation made by Dr. Ebers that these portraits represent men and women between the ages of twenty and sixty, the latter being of rare occurrence, suggests the fact that the same remark applies to the "ka" statues of the Egyptians, which only represent the dead in all the vigor of life and never in the decrepitude of old age. Behind this custom—which in later times was no doubt conventionally observed without any very exact knowledge of its primitive intention—it is difficult not to remember the idea which originally gave rise to the placing of the portrait statue in the grave, i. e., the necessity existing in the Egyptian mind for supplying the dead with a false body for the "ka" to dwell in and the desire, natural under the circumstances, to make that artificial body not only in the exact semblance of the defunct, but in his semblance when in the full possession of his strength, as this would insure him the continuance of this condition.

It seems probable that those foreigners who adopted the Egyptian burial customs may have been more or less imbued with the idea that gave them rise, and consciously or unconsciously carried them out in this detail.

The very unequal merit of the paintings is strongly suggestive of the idea that the finest among them are the work of the artists of the large cities, possibly of Alexandria. The necropolis of Kerke where they were found was obviously held in special veneration by the people, not only of the neighborhood, but also of distant towns. The number of men and women of rank wearing the purple and other evidences of high lineage shows that we are in the presence of the great in the land, and reminds us that Arsinoë was an important city in Græco-Roman times, although, as pointed out by Dr. Ebers, many

NOLM

FIG. 25.—PORTRAIT BUST, ETC., FROM ROMAN MUMMY, FOUND IN THE GREAT OASIS OF THE LIBYAN DESERT AT EL KHARGEH—USED THERE AS THE PORTRAIT PANELS WERE USED BY THE GRÆCO-ROMAN INHABITANTS OF THE FAYÛM. GRAF COLLECTION.

born there, but living in Alexandria or Memphis, may have had their remains sent home for burial.

The collection also includes some curious portrait busts (fig. 25), which at El Khargeh in the great oasis of the Lybian Desert, replaced the portrait panels upon the mummies. Some forty or more have recently been found, and Professor Gooth, of Munich, after analysis, has declared them to be made of a sedimentary clay, artificially mixed with sand, or of a natural form of impure gypsum unusually rich in clay. They are painted; the eyes, of talc, are inserted according to ancient Egyptian custom, and although the men whose effigies they are were obviously Greeks or Romans, the little funeral Osirian scene depicted at the back shows them to have adopted the Egyptian customs and mode of thought concerning death. The busts were attached to the upper part of the mummy. These tell the same story as the Fayûm paintings with regard to the commingling of races in Egypt. Although those exhibited show men of an Aryan cast of features, others have been found representing pure Semites or Egyptian half-breeds. The great temple in the oasis was built by Darius I, and the Persians made a deep impression upon its population. Under the Lagidæ it became strongly Hellenized, and in Roman times garrisons protected its commercial stations.

It is worthy of remark that the more important archæological collections representing the great civilizations of the Old World displayed at the World's Columbian Exposition were especially rich in material elucidating certain questions relating to the intercourse of the Mediterranean peoples, at different epochs, with other nations of the ancient world; indeed, with the exception of the Babylonian collection first mentioned, all the important material exhibited may be said to have had a bearing upon the subject. Another interesting exhibit consisting of a small series of Buddhistic sculptures exhumed from the ancient ruins of Lani-Ghat, and at Takt-i-Bagh in the Peshawar district (northern frontier of India), showing undoubted Greek influence, was displayed by Mr. G. H. Thomson. In these, the attitudes of the figures, the treatment of the hair and the drapery, etc., show that, although the subjects are distinctly Buddhistic, and the types represented are decidedly oriental, the artists who carved them were influenced by Greek models and impressed with Greek methods.

There has been much discussion as to the date of the Græco-Buddhistic sculptures of the Peshawar district. Among those exhibited at Chicago there is one, however, that seems to have been the work of an artist influenced by the school of art which inspired the statue of Demosthenes at Athens, and this, according to the owner, would tend to fix upon the time following the conquest of India by Alexander as the probable date of the strongest Greek influence over Hindu art. The general tendency of science, however, is in the direction of a more

recent date, and it is the opinion of the well-known Scotch Indianist, Dr. James Burgess, director-general of the archæological survey of India—as recently expressed to myself—that such sculptures must be assigned to the beginning of the Christian era, and are probably due to the influence of the Sassanian Empire.

Greek archæology was worthily represented by a fine collection of casts, exhibited by the Greek Government and illustrating the best results of the explorations conducted in Greece in the last few years.

The archaic period was represented in the series by casts of the finest early sculptures recovered upon the sites of Argos, Lycosura, Epidaurus, Athens, Melos, Delos, etc., beginning with the famous lion group over the gates of the citadel of Mycenæ.

Following these early productions, statues, and reliefs of the fifth and fourth centuries B. C. illustrated the development and history of Greek art with such fine examples as the splendid group of Demeter, Persephone, and Triptolemos, found at Eleusis, a slab of the frieze of the Parthenon, the superb head found by Dr. Waldstein in the Heraion of Argos, and specimens of the schools of Phidias, Scopas, and Praxiteles.

The series was completed by a number of sculptures of the Hellenistic and Roman age, such as the collossal Themis found at Rhammus, and other equally important works of artists of the latter period of Græco-Roman art.

The presence of such a collection in the department of anthropology formed in itself an important step in the history of museum methods.

Greek art has, until comparatively recently, been studied apart from all others; and purely from the artistic standpoint. Here, however, surrounded by man's naïve and efforts to carry out crude conceptions by means of primitive technical devices and exhibited in its process from the crude, xoanon-like statue of Artemis to the Hermes of Praxiteles, it took its place in the history of man's evolution and stood as the culminating point of his artistic genius.

NOTES ON ESKIMO TRADITIONS.

By HARLAN I. SMITH.

Most of the households in the Eskimo village, belonging to the World's Columbian Exposition, were from localities under missionary influences. Two families, however, were from Nachvak, farther north than the others, and at some distance from Rama, the most northern mission. From Conieossuck, the head of one of these households, through the medium of Georgie Deer, a bright Eskimo from Rigoulette, were obtained the two tales which follow; the narrator reciting a few words at a time, and pausing until these were interpreted and written out.[a]

I. OLŬNGWA.[b]

In the old times, Sedna[c] came up to the surface of the water, and while there was seen by an old heathen[d] woman named Olŭngwa, who

[a] The Eskimo story teller, of which class there is usually a representative in each village, is obliged to narrate the stories correctly, as it is considered a part of the duty of the audience to correct his inaccuracies.

[b] This story seemed to be made up of several short parts, some of which are apparently incomplete and show but little relation to each other. Collected October 2, 1893. Olŭngwa, as the writer understands, was a medicine woman, perhaps an angakok, or possibly a pivdlerortok, "a mad or delirious person," able to foretell events, unfold the thoughts of others, and "even gifted with a faculty of walking upon the water, besides the highest perfection in divining, but was at the same time greatly feared." (Rink's Tales and Traditions of the Eskimo, p. 56.)

[c] "Sedna" has been substituted in each case for the following words of the interpreter, "the woman whose fingers had been cut off," as it is supposed that the phrase refers to her. Their Supreme Being is a woman whose name is Sedna." (Boas, "Central Eskimo," 6th An. Rep. Bur. Ethnology, p. 583.)

When telling of Sedna, Conieossuck and his wife would clutch the top of the table, from the side, then letting go the right hand would draw it edgewise over the fingers of the left, or she would hold both hands while he struck them with the edge of his, thus representing the cutting off of Sedna's fingers, the story of which also is related in Boas's "Central Eskimo."

[d] "Heathen" was used almost invariably by the Christianized Eskimo at the village to designate those from the north of Labrador, or even their own ancestors previous to their conversion by the Moravian missionaries. In this instance, however, it was probably used by the interpreter to signify medicine or angakok, and in footnote 7 of this tale the reference to "angakok" must be understood in this connection.

had been left on an island, with two or three children, by a party of heathen, while on their way to visit other heathen.

Olŭngwa wanted Sedna to go below the water again, and so went walking out to her upon the water and combed her hair.[a]

After Olŭngwa combed her hair, she returned to the bottom.

There was a party of heathen men talking about something in a dark house, where there was no light. In the winter one of these men went out to the island because Olŭngwa was there. One day Olŭngwa left the man and walked on the water to her home, where her husband gave her his leader dog. She then went back to the island in the night, and, going to the door of the house, asked the man she had left on the island the day before what they had to eat.

In the winter she went home. There an old heathen[b] man (angakok?) was talking with another heathen[b] man about her. He would not believe her to be a heathen.[b] She was listening to them, but they did not know it. He said: "How is it she can not melt solder,[c] as I can do,[d] if she is a heathen."[b] While he was talking she came in through the door. Then she went out and took a handful of sod or turf, and going in again held it out in her hand. She said to the man who did not believe she could melt solder, "Here is some turf." She smacked her other hand on top of it several times while they looked at her. She said, "Turf now," and the last time she smacked her hand on the turf it melted, and running between her fingers fell on the floor as shining solder. The man who did not believe became ashamed, and next day went and "hung"[e] himself, because he was wrong and Olŭngwa could do what he could not.

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[a] It is supposed that Sedna's hair was infested with vermin, that after the combing all this vermin turned to seals and her hair to flaunting seaweed, and that this was done by Olŭngwa as an atonement.

[b] "Heathen" was used almost invariably by the Christianized Eskimo at the village to designate those from the north of Labrador, or eved their own ancestors previous to their conversion by the Moravian missionaries. In this instance, however, it was probably used by the interpreter to signify medicine or angakok, and in footnote [d] of this tale the reference to "angakok" must be understood in this connection.

[c] It was impossible to determine the exact significance of the word "solder," as used by the interpreter.

[d] The following explanatory sentence inserted by Conieossuck at this point of the story suggests either that he did not believe in the angakok or that he understood some of the impositions used by them to impress the credulous. "He did not really melt solder. He stole it from the whites and made others believe he melted it."

[e] The words of the Eskimo interpreter, and later of the informer, have often been remodeled and arranged to complete the sense; however, those included within quotation marks are exactly retained. In many cases where more specific words should be substituted the lack of familiarity with the exact sense of the words used will not permit a change.

II. THE GIRL WHO MARRIED THE JAW BONE OF A WHALE, AND THE ONE WHO MARRIED THE WING BONE OF AN EAGLE.[a]

There was once a number of young girls who took for their husbands anything that they could get, even such things as stones and bones of dead animals or people.

A girl once took a stone for her husband, and because she did this she was turned into a stone.[b]

Another took a whale's jaw bone for her husband,[c] and then the jaw bone turned[d] into a living whale, which carried her off into the water, and to an island.[e] After they got to the island the whale turned into a man;[d] and they lived there as man and wife. Then the father and mother[f] of the girl set out in a boat to get her. Her husband, fearing she might try to get away, tied one end of a line, such as was used in fishing, around her, and fastened the end of it to a stake used in stretching skins. This stake was driven into the ground inside the tent, so that she could go out and around as far as the line would let her go.

When the girl's father and mother came to get her, she was out of the tent, and her husband was inside; so he could not see her. She kept the line as tight as usual, and, untying it from herself, tied it to a stake, so that it would be kept tight. She then got into the boat, and went off with her father and mother. Her husband thought she was there, because the line was tight. At last he pulled on the line to bring her in, but it did not move. Then he pulled harder; the stake came up, and he pulled in the line, and saw the stake at the end of it. He then went out to look for her, and saw that she was gone. So he turned into a whale,[d] and went after the boat as it was going off.

When he began to catch up to the boat in which was his wife, with her father and mother, they threw out her boots. Coming to these he

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[a] This story in substance was also known in Greenland and is recorded as "A Tale about Two Girls." Rink, 8th Tale, p. 126, as constructed from two manuscripts, one from Labrador and the other written down in Greenland prior to 1828.

[b] The girl that took the stone for a husband is not included in the story recorded by Rink.

[c] In "A Tale about Two Girls," the girls were playing with the bones of the whale and eagle, and did not take the bones for their husbands, but took the living whale and eagle that came when each said she would have such a one for her husband.

[d] There is no transformation of bones to animals or animals to men, and vice versa, in the tale recorded by Rink, but the real animals appear at such times, except in the one instance where the whale turns into a piece of whalebone.

[e] In "A Tale about Two Girls," the whale takes the girl to the bottom of the sea, after making her eyes and ears impenetrable. There she had to pick parasitic crustaceans off his body when he was at home.

[f] In the tale recorded by Rink, the brothers go for her, not the parents. They try three times before succeeding in building a boat sufficiently swift for the task of rescuing her from the whale. The one which they use rivals the sea birds in swiftness.

stopped to fight[a] them, and stayed a long time until the boat had left him a long ways behind. Then he left the boots, and started after the boat. As he again neared it, they threw out her breeches and he stopped to fight[a] with the breeches until the boat had left him far behind. He then gave chase again, and as he caught up with it, they threw out her coat (atĭgĭ). This was the last thing she had to throw out, and they got to the land while he was fighting with the coat. At last he left it, and went on after her. But as soon as they had reached the shore, they had left the boat and gone inland. The whale reached the boat at last, and broke it up. As he did this, his head turned to bone, and he tried to go on shore after his wife, but he could not get beyond the beach, although he rushed against it many times. At last when he found he could not go after her any farther, he turned into the bones of a whale's head.[b]

Another girl took the wing bone[c] of an eagle for her husband. The bone turned into an eagle,[b] and carried her to a shelf of rock on the face of a cliff, from which she could not get away. Then he used to go and get rabbits[d] and birds, which he took there for her to eat. The girl could not live there, as she could not get away, but had to sit still on the small shelf of rock. She could not get up if she wanted to. So every time the eagle went away after birds and rabbits, she would take the bones[e] of the birds and rabbits that he had brought to her and braid them into a rope. One day he went and got a young deer[d] to take to her. While he was away she made the bone string long enough to reach to the base of the cliff,[f] caught a stone with it, and hauled it up. In making the bone string, she had worn off the ends of her fingers, so that the finger bones stuck out, being bare of flesh. She then went down on the string, and went home to her friends. When the eagle came back, and found her gone, he went to her tent at home and stayed near it, to try to catch her out of doors, and take her back. But before she went out, one of the men killed the eagle

[a] The exact meaning of "fight" in this connection is rather obscure, but the interpreter could give nothing more definite.

The custom of throwing out garments to attract the attention and delay pursuing animals is not uncommonly met with in English and German stories. Different garments are mentioned in "A Tale about Two Girls," but the difference in the simple enumeration of a series of garments seems of slight importance in this connection.

[b] There is no transformation of bones to animals or animals to men, and vice versa, in the tale recorded by Rink, but the real animals appear at such times, except in the one instance where the whole turns into a piece of whalebone.

[c] At this point the narrator touched his upper arm.

[d] Only birds are mentioned in "A Tale about Two Girls."

[e] In "A Tale about Two Girls," the more appropriate word "sinews" is used instead of "bones." This difference, however, may be due to difficulties in interpreting.

[f] In "A Tale about Two Girls," a kayaker, whom she saw out at sea one day, sends a boat to her at the bottom of the cliff.

with a bone arrow. When he killed the eagle, it turned into the same wing bone that the girl had taken for a husband.

III. INITIATION OF THE ANGAKOK.[a]

The following information was obtained from Peter Polisher, the oldest Eskimo in the village, and familiar with English. He claimed to be of full blood, coming from Rigoulette on Hamilton Inlet. A firm believer in the Moravian teachings and an ardent reader of his Bible, printed in Eskimo dialect, he could not understand why anyone should be desirous of obtaining untrue stories, or descriptions of heathen ceremonies and beliefs; but being assured that the object was comparison with the tales and beliefs of other people, and thinking that it would be well to explain how his people had formerly lived, so that the advantages of his present faith might be made more apparent, he tried to give as much information as possible.

When the Eskimo desired to make an angakok, he said, they would take a man and double him up with his knees to his chin, tie him with seal lines as if about to kill him, and place him on the floor[b] in the center of the house. After this, they put out the lights, and sang a heathen song.[c]

After this the man would groan. As he groaned "the old fellow" would untie him. The seal lines used in tying him would "whip" around the house as they came undone and fell off from him, being untied and thrown back by a spirit.[d]

After this ceremony of becoming untied by the spirit, he was the "head one."[e]

Tasting the water.—After this, each one would give him a drink of water out of a seal-skin cup made for that special occasion.[f] This drink he declared good or bad as it was given him by various persons. Sometimes he would affirm the drink to taste good at one time, and bad at another, even when it was from the same cup of water.

Fire eating.—Then they would light the stone lamps and sing a song

[a] To signify a spirit or an angakok, Peter used the words "old one," "old fellow," "dark one," "bad one," "priest," "devil," or "ghost." In these words, as in most of the material obtained from Peter, it is not difficult to detect missionary influences.

[b] Peter doubled himself up, to show the position, and produced a piece of seal line, such as was used in the tying.

[c] Meaning a non-Christian, or ancient song.

[d] Peter suggested that, although the people believed this, perhaps some of the friends of the man untied him, or even sleight of hand might have been resorted to by those officiating in the ceremony.

[e] Medicine-man or angakok.

[f] It is possible that this may have been done at various times as well as directly following this ceremony. The exact sequence and connection of the various ceremonies, in which the angakok participated after his initiation, are not well understood by the author.

in which all would join. While they did this, the angakok would "act wild," and "eat the fire" from the wicks and lamps. In this way he would put out all the lights.

Eating the liver of the Angakok.—When a man was "made" an angakok, the "old fellow" would come to him with a knife like a cheese-cutter's knife, and try to kill him. The angakok would try to elude him. If the "old fellow" killed him, he cut out his liver and ate it. Both the "old fellow" and the angakok possessed the power to "go right through" the side or roof of the house where there was no door or other opening, so that the chase was a lively one. The angakok often escaped, but sometimes he was caught, and the "old fellow" feasted on his liver.

Teachings of the Angakok.—The angakok was supposed to tell the people what they should do, and they sometimes met to ask him.[a]

On such occasions all would go into one house; as soon as they were all in, the lights would be put out. When all was dark inside the house, they all sang heathen songs "on the old fellow's side." Then the angakok "would make all kinds of noise." While this went on the people asked him what they should do. Then he would call on one of the "bad ones to tell him," and then he would tell the people what the "black one" told him to tell them.

Sometimes he would tell the married men that they should change wives for a time.[b]

Sometimes when there was only one or two of his friends near, the angakok would "have fun." He would box, wrestle, and talk with them.

Diet regulation by the Angakok.—The angakok ordered that when a seal was killed, the men eat certain portions and the women certain other portions. The fore legs[c] "had to be" eaten by the men only, and the lower part had[d] to be eaten by the women only. The men had to eat the "hind legs," and the men and boys the head. The heart belonged to the women, and the men were to have none of it. If the men ate any of the heart, and then ate any plant, berries, or fruit, they would be poisoned and die.

They were also told that after eating a fish or a seal they must not eat any fruit or plant, and that if they did, it would poison them. There were both black and red berries, and they were commanded that the men only should eat the red berries, and that the black berries were only for the women.

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[a] Peter said, "Just as we now learn what to do from the Bible."

[b] In Boas's "Central Eskimo," p. 593, among the commands issued by the angakok, as to the manner of atonement, is mentioned an "exchange of wives between two men." Peter said, "That is not the way now."

[c] Peter touched his forearm.

[d] Peter touched his upper arm.

When a "lot of men" go hunting walrus, the game is divided among their households. The first one to spear the walrus has one of his "ivories," the second gets the other, and each one that spears it gets a special piece of the meat, but all that go hunting get a part. When a man gets an "ivory," he uses it to make a "good dart" or harpoon.*

The "heathen" Eskimo have one name, while those who have become Christianized, or who have been long in contact with European influence, have two or more. That Peter was correct in this, so far as the individuals at the village were concerned, was apparent on studying their names. One little fellow born at the exposition was named Christopher Columbus William Polisher.

The influence of mission teachings on the names is very great, many from the Bible being used, as in the name of one of Peter's household: Mary Magdalene Polisher.

According to Georgie Deer, at Rigoulette, seal-skin clothes are no longer in use, the people dressing in garments of the ordinary civilized pattern, made of cloth bought from the Hudson Bay Company. The men, however, have their hair seal-skin coats and breeches, which they use only when fishing in bad weather.

In regard to methods of hunting and fishing, Georgie said that when a seal is caught, the skin is cut around the body, and pulled off at each end without splitting it. Then they cut around the skin, until a long line is produced. When a man goes to hunt seal at holes in the ice, his wife accompanies him, to hold the line that is attached to his spear. They cut a notch in the ice, and, taking a bone lever which has been sharpened at one end, she holds it vertically and so that the sharp end is pressed hard down into this notch. The line then being fastened to the bone, close to the ice, is easily held by her, even when a very large seal is speared. Perhaps it was from the Europeans of the trading posts that the Eskimo children learned to play with dolls; at any rate, Georgie's babies took as much comfort with their rag dolls as could any child with one of the most exquisite manufacture.

Georgie had heard of various tribes living inland on this side of his home. One of these tribes, the "Nascapee" or "Nasquapee" Indians, live in what he called the Mingan country. They wear a long snowshoe, while the Indians near his home at Rigoulette wear round snowshoes. They live by hunting deer, for which they use little hunting dogs. These people are very particular that their dogs do not eat certain parts of the bones of the deer and other animals. They believe that if the dog eats such parts of the bones or certain parts of the meat, they would have bad luck. When they kill any otter, they

*Several of the Eskimo drew pictures of harpoons, etc., but none of these exhibited much artistic skill. However, a specimen of penmanship (No. 350) was secured from one of Peter's household, which, considering advantages and environments, was surprisingly good.

hang the feet up to a tree for good luck. They believe a partridge must be picked while warm and hung to the belt by the wing as soon as killed, or they would be unlucky.

On killing a porcupine, they tie a string to one fore and one hind foot, and so carry it home on their back. As soon as they get home, the women sharpen a stick and put it through up to the nose, then they blow up the animal with wind, singe the hair off, and hang him up over the fire so that he will turn round and round until cooked. Then, for good luck, they hang up a "green brush" in the same way and leave it until all the "green things" are burned off by the fire.

A COLLECTION OF PICTURES AND OTHER OBJECTS ILLUSTRATING THE MANNERS, CUSTOMS, AND CONDITIONS OF THE PEOPLE OF THE LATIN-AMERICAN REPUBLICS.

[Exhibitor, Bureau of the American Republics, Washington, D. C.]

By THOMAS WILSON, *Judge.*

The Bureau of the American Republics is an institution maintained at Washington by the nineteen independent nations of the American continents "for the prompt dissemination of commercial information." It was established upon the recommendation of the International American Conference for the purpose of making known to the world, and particularly to the people of the United States, the resources, industries, progress, and commercial advantages of the republics of Mexico and Central and South America. Its headquarters are at Washington, D. C., and its originator and first director was Mr. William E. Curtis. He organized the present exhibit under the auspices of the Department of State. It is located in the eastern gallery of the United States Government Building and consists of 1,403 entries of maps, charts, sketches, photographs, and pictures illustrating the various industries of these countries, together with 872 samples of commercial objects made, used, or required in some of them. A great obstacle to the extension of the export trade of the United States with Mexico, Central and South America, and the West Indies, is the inability of our merchants and manufacturers to provide the classes of goods required for their markets. The manufacturers of Europe have become familiar with the peculiarities of a trade that has never been cultivated by the manufacturers of the United States, who have been absorbed by the demands of a domestic market. The exhibit of the Bureau of the American Republics furnishes those who desire to attempt to exploit this new field with the necessary information as to the requirements of consumers in these countries, and it is believed that the collection is complete enough to be of great benefit. Information was obtained from various consuls of the United States. Competent agents were sent to the chief ports of South America, visiting the principal points of distribution and collecting samples, in piece and package, of articles just as they arrive from Europe, and as they were prepared for sale and apportionment. By this means, for the first time merchants and manufacturers of the United States have now an opportunity to see the kinds of goods, the make, the finish, the packages and manner of packing, the size and weight of the same suitable for inland, wagon, and mule carriage; and in this way they will be instructed in the wants of the special country to be supplied.

HISTORICAL AND EDUCATIONAL REPORT ON PSYCHOLOGY.

By Prof. J. MARK BALDWIN.

An international exhibition, as far as scientific progress may enter into it and show itself advantageously, should have without doubt the two main aspects—"historical" and "educational." For science becomes conscious of itself only in the light of a due appreciation of its historical development, and the community or nation really becomes conscious of it, in a way to utilize it intelligently, only as it becomes a part of national education.

I shall accordingly endeavor to present the subject of psychology under these two aspects, having reference mainly to the exhibits at the Columbian Exposition, but feeling at liberty to supplant them by verbal treatment in a topic which is not material enough to be adequately represented by material apparatus. I am glad to avail myself also in what follows of quotations from authors whose opinions are authoritative and whose views will thus themselves tend to make this paper truly representative.

I. HISTORICAL.

Modern psychology has had its principal development in Great Britain, Germany, and France. Germany has undoubtedly had greatest influence in this movement considered in all its branches. The two main currents of development designated previous to the rise of the new so-called "scientific" psychology, as respectively "speculative" and "empirical," had their initial impulse, as well as their fruitful pursuit, respectively in Germany and Great Britain. German psychology down to the rise of the Herbartian movement was a chapter of deductions from speculative principles; English psychology was a detailed analysis of the experiences of the individual consciousness. Kant, Fichte, and Hegel may sufficiently represent the succession in Germany; James Mill, John Stuart Mill, Hume, Reid, and Bain that in Great Britain.

The work of Herbart and his school tended to bring a more empirical treatment into German thought, and its significance was twofold. It excited opposition to the speculative method, and it prepared the Germans for the results of English analysis. It is further a legitimate supposition that the spirit of experimental inquiry which has swept

over Germany in this century was made more easily assimilable by workers in this department, also by the patient and extraordinary attempt of Herbart to construct a "mechanic" and "static" of mind in his "Psychologie als Wissenschaft," (1824).

To German thinkers also belongs the credit which is due to originators of all new movements which show their vitality by growth and reproduction, in that the experimental treatment of the mind was first advocated and initiated in Germany. But of this I write more fully below.

The contribution of France to psychology has been decidedly of less importance; yet the work of these writers has also illustrated a fruitful and productive movement. It has been from the side of medicine that French work has influenced current widespread conceptions of consciousness. Mental pathology and the lessons of it for the theory of the mind have come possibly most of all from France, or, at any rate, not to disparage the admirable recent work of English and German investigators, the tendency, so to speak, of the French treatment of consciousness has been to approach mental operations from the abnormal side.

In America the influences which have tended to control psychological opinion have been mainly theological on one side and educational on the other. The absence of great native systems of speculative thought has prevented at once the rationalistic invasions into theology which characterized the German development and the attempts at psychological interpretation which furnished a supposed basis of fact to their idealistic systems. In Germany various "philosophies of nature" sought to find even in objective science support for theoretical world dialectic, and psychology fared even worse, since it is par excellence the theater for the exploitation of universal hypotheses. But in America men did not speculate much; and those who did were theologians. So, naturally, the psychologists were theologists also. Jonathan Edwards had a doctrine of the agent because free will was a question of theology.

The educational influence was auxiliary merely to the theological. The absence of large universities with chairs for research; the nature of the educational foundations which did exist, under denomination control; the aim of education as conceived in the centers where the necessity for supplying growing towns with pastors was urgent; the wholesome fact for our civilization that the Puritans had traditions in favor of the school and the religious school—all these things made it only necessary that books sound in their theological bearings, or affording homiletic lessons in living, should be written in a topic of such central importance. Even the term "psychology" is only now getting domesticated; "mental" and "moral" philosophy were the titles of courses of instruction on the soul.

The type of philosophy which these conditions encouraged was, it may easily be imagined, realistic; and it is probably for the reasons which I have indicated that the Scottish natural realism was the American type of thought, and is now, except in the great university centers where systematic philosophy has become an end in itself, apart from its duty to theology and education. As far as psychology is concerned, this realistic tendency was a great good. It led to a magnification of mental reality, to a reverence for the "utterances of consciousness," to a realistic interpretation of the "immediate knowledge of self," to the firm settling of the great "intuitions," cause, time, space, God; and in as far as this led to the direct examination of consciousness and to the testing of philosophical claims by consciousness, it prepared the way for a better and a broader method. This tendency is marked even in the more influential works in theology. Channing and Emerson, no less than Smith and Charles Hodge, lay the cornerstone of argument again and again in the proof "from consciousness."

The tendency to a psychological view of philosophy and its basis in the religious motive is seen also in Scotland, the home of realism; and it is there a part of the British method of thought which I have already spoken of. The works on psychology written in America up to 1880 were, as we would expect, from the hands of theologians and educators, usually both in the same person; for it is a further proof of the association of psychology and theology that the mental and moral philosophy in the colleges was, almost without exception, put in the hands of the president of the college, and he was by unanimous requirement a preacher. So were written a series of works which are landmarks of American scholarship, props of evangelical theology, disciplinary aids of the highest value to the growing student, and evidences—to revert again to my argument—of the twofold influence I have indicated. Edwards's "Freedom of the Will," Tappan's "Review of Edwards" (1839) and "Doctrine of the Will Determined by an Appeal to Consciousness" (1840), Hickok's "Rational Psychology" (1848) and "Empirical Psychology" (1854), Porter's "Human Intellect" (1868) and "Moral Science" (1885), McCosh's "Psychology" (1887) and "First and Fundamental Truths" (1889)—these and other books like them show the psychology of America up to about 1880.

Speaking for psychology alone, it is easy to point out their merits and defects—not in my individual judgment, but as compared with the standards of the present year of the Exposition. It is necessary, however, rather to show this by sketching the present and showing the new elements which have modified the American work and whence they came.

Coming to the present state of psychological thought, my task is made easier by reason of the divorce which has been forced between psychology as a science on one hand and metaphysics on the other. As

was said above, Herbart, while failing in his attempt to apply mathematics to mental "permutations and combinations," yet prepared the way for a new treatment of mental phenomena. After his attempt it began to be seen that the facts of conscious life were first in order of importance, and were capable of treatment in a detailed way quite independently of the questions of being, the absolute, and the like. The works of Volkmann, "Lehrbuch der Psychologie" (3d ed., 1884), and Lipps, "Die Grundthatsachen des Seelenlebens" (1883), illustrate this.

This was only to begin to do what had been doing in England since Locke. But the Germans now went further; they ask the question—which had been groped upon before by Descartes, by Leibnitz, and by Reid—how can psychology be a science when one of the evident conditions of the flow of mental states, of their integrity and their trustworthiness, the brain, is left quite out of account? What is the law of connection of mind and brain? And is it possible to modify the brain and so to modify the mind? If so, then that great instrument of scientific work, experiment, may perform a part for the psychologist also, and his resources be magnificently enlarged.

This is the question of experimental psychology. It was answered in Germany in the affirmative. Lotze, in my view, deserves the credit of it, the credit of the great-minded constructive pioneer; and Wundt is the founder of the science in the sense that he first realized the expectations of Lotze's genius by actually planning and executing experiments of wide range and on a large scale, which made the affirmative answer an irreversible fact of history. Lotze's "Medicinische Psychologie" appeared in 1852, Wundt's "Grundzüge der physiologischen Psychologie" in 1863. Between the two, however, came Fechner, whose theoretical construction of the new work and its methods shows all the exactness of treatment of similar discussions of natural science principles by electricians and chemists, and published the formulas in which he attempted to give universal statement to the discoveries of E. H. Weber on the intensity of sensation-states. Fechner's "Elemente der Psychophysik" appeared in 1860.

Apart from the actual development of this new method—a point to be spoken of later on—it has profoundly modified the general conception of psychology even where its validity as a method has been denied. There has been nothing less than a revolution in the conception of psychology since the publication of the works just named. One of the motives of this revolution came thus from Germany. The other—for it has two great phases—is due to English thinkers, the evolutionists, of whom Herbert Spencer is the chief. These two influences are seen in two great points of contrast, easily made out between the psychology of to-day and that of yesterday in America. The latter I have described above. Its two main characteristics, for

purposes of the present contrast, are first, its character as so-called "faculty-psychology;" and second, its character as holding to what I may call a "ready-made" view of consciousness—technically, an "intuition" view of consciousness. In opposition to these characters, current psychology is "functional"—holding to mental "functions" rather than to mental "faculties," and finds this function to be "genetic" rather than "intuitive"—the functions "grow," instead of being "ready-made."

The old conception of "faculties" made the different phases of mental process in large measure distinct from one another. Memory was a "faculty," a "power" of the mind; thought was another, imagination a third. The new functional conception asks how the mind as a whole acts, and how this one form of activity adapts itself to the different elements of material which it finds available. The old terms "memory," "thought," etc., are retained, but with the distinct understanding that they do not stand for divisions in the mind, or different processes, one of which may be held in reserve when another is acting. On the contrary, the process in consciousness is one, and it is a psychophysical process as well. The particular way in which this one function shows itself is a matter of adaptation to the changing conditions under which the activity is brought about. This transition is due in part, also, to the insight of Herbart, and to the demand for unity insisted upon by the evolutionists.

The other point of contrast is equally plain. The "genetic" point of view in current discussion is opposed to the older "intuitive" point of view. The mind is looked upon as having grown to be what it is, both as respects the growth of the man from the child, and as respects the place of man in the scale of conscious existences. The understanding of mental facts is sought in the comprehension of their origin as well as their nature; and the question of the validity or worth of "intuitive" beliefs in consciousness is subordinated to the question as to how the mind came to have such beliefs. The critique of their "validity" is left over for metaphysics.

Both of these points of contrast have been further defined by the progress of general philosophy in America. The demand for unity in mental interpretation has not come from naturalistic evolution alone; an equally pressing demand has come from idealistic metaphysics, which seeks for continuity in the natural series as zealously as does the advocate of evolution. The influence of Hegel, as interpreted in the works of Green and later those of Caird, has been potent in effecting this transformation. It is easy to see, also, that the same union of forces is quite feasible as respects the genetic development of consciousness, although the new idealists have not done justice to this growing tendency in modern psychology.

The line of cleavage, in the current discussions of general psychol-

ogy, is drawn on the question of the interpretation of mental "function," both sides claiming the same full liberty of genetic research and the same resources of analysis and experiment. The "associationists," on one hand, carrying on the tradition of the British empiricists, construe mental function after analogy with the ordinary interplay of forces in the objective world; the "apperceptionists," on the other hand, hold that mental function is an irreducible form of cosmic process. Apart from original monographs on special topics, no work on psychology to-day commands much attention, either from psychologists or from students of philosophy, which does not show itself alive to this main issue. The works of Lotze and Wundt have had great influence upon Americans in the direction of this general statement of the problems of psychology; and it is especially the philosophy of Lotze, which is replacing, by a reasoned and critical realism, the earlier theological dogmatic view so long prevalent in the United States by inheritance from Scotland.

On the literature of present day psychology I can do no better than quote the following passage freely translated from the most recent German work on general psychology, itself fully representative of the present state of knowledge, "Grundriss der Psychologie," by Dr. O. Külpe, of the University of Leipzig (pp. 27ff):

About the middle of the nineteenth century experimental and psycho-physical psychology began its course in Germany. While Herbart recognized a three-fold influence of the body upon the mind, it was Lotze who made a thorough beginning in the employment of the data of physiology. Lotze, indeed, began his work with certain metaphysical expositions after the manner of the older German writers, and is very far from the recognition of a universal psycho-physical parallellism. But he does not hesitate to speak of the nervous conditions of mental processes, and he had the good fortune to suggest hypotheses of value where exact knowledge was wanting. The real foundation of experimental psychology was laid, however, by G. T. Fechner, who sought to carry out in a thoroughgoing way the conception of a functional relation between mental and physical processes. Although the mathematical form which he gave to this relation does not hold, yet he gave to the exact science of psychology an extraordinary impulse by reason of the new conceptions which he introduced, the methods of procedure which he both formulated and applied, the working over which he gave the material he had in hand, and the observations and researches which he himself carried out. The union of the experimental and psycho-physical was finally accomplished by Wilhelm Wundt, in his classical "Grundgüge der physiologischen Psychologie" (1874, 4th ed., 1893). By this unity of conception and by his comprehensive treatment of all mental phenomena he has made the current phrase, "modern psychology," applicable. Wundt gave a further important impulse to the cultivation of experimental psychology by founding the laboratory in Leipzig in 1879, and establishing the "Philosophische Studien," a journal devoted mainly to the publication of researches from his institute.

Additional works of very recent date may be mentioned, which must be reckoned in their character as belonging to the modern psychology thus founded by Wundt, although they differ more or less essentially in system and in theory from him and from one another: Höffding, "Psychologie in Umrissen," 2d ed., 1893, German translation from the Danish (English translation, 1891); Ladd, "Elements of Physiological

Psychology," 1887; Sergi, "La Psychologie physiologique" (translation from the Italian); W. James, "The Principles of Psychology," 1890; Ziehen, "Leitfaden der physiologischen Psychologie," 1891, 2d ed., 1893; Baldwin, "Handbook of Psychology," 1891 (2d ed.; 1st ed., 1889–90); J. Sully, "The Human Mind," 1892.

We may mention also certain periodicals which represent the same current of psychological thought: "Philosophische Studien," edited by W. Wundt (vols. 1–8, 1883ff); "The American Journal of Psychology," edited by G. St. Hall (vols. 1–5, 1887ff); "Zeitschrift für Psychologie und Physiologie der Sinnesorgane," edited by H. Ebbinghaus and A. König (vols. 1–5, 1890ff).

The part taken by American students in the present psychological movement is seen in the fact that of the seven works thus cited by Külpe, three are by Americans, and to them must be added "Psychology: Descriptive and Explanatory" (1894), by Geo. T. Ladd, and the journal "The Psychological Review," edited by J. Mck. Cattell and J. Mark Baldwin (vol. 1, 1894). The position of psychology in the American colleges and universities is described in a further section below.

Other important contributions to experimental psychology—apart from the long series of monographs and research articles published in Germany and America, of which "The Perception of Small Differences" (1892), by Fullerton and Cattell, may be considered one of the best examples—are Helmholtz, "Physiologische Optik" (1867, French translation, 2d ed., 1890ff), and "Tonempfindungen (1863, 4th ed., 1877, English translation, 1875, 2d ed.); Stumpf "Tonpsychologie" (1883, 1890), and Münsterberg "Beiträge zur experimentellen Psychologie," Parts I–IV (1889–1893).

The contribution from the side of mental pathology has become important on account of the rapprochement which has obtained in recent years between the alienist and the psychologist. The works of Pierre Janet, "Automatisme psychologique" (1889), and "L'État mental des Hystériques" (1892–93), and of Bernheim, "Suggestive Therapeutics," English translation (1889), and "Études de la Suggestion" (1892), are most important. To them should be added the works of Ribot, "Diseases of the Will," English translation (5th French ed., 1889), "Diseases of Memory," English translation (5th French ed., 1888), "Diseases of Personality," 2d edition (1888, English translation, 1891), together with the many original contributions on the subject of hypnotism and aberrations of personality published in the "Revue Philosophique," edited by Th. Ribot (Vols. I–XXXVI, 1876ff) and summed up in part in "Les Alterations de la Personalite" (1893) of Alf. Binet.

Further, the treatment of psychology in accordance with the British tradition from the point of view of description and analysis has been carried forward by Bain, "The Senses and Intellect" (3d ed., 1868), and "The Emotions and the Will" (3d ed., 1888), Ward in the article "Psychology" in the Encyclopedia Britannica, ninth edition, and Stout

in his "Principles of Psychology" (1894). This type of research has also had its organ of publication in "Mind: a Journal of Psychology and Philosophy." edited by G. Croom Robertson (Vols. I–XVI, 1876ff), and by G. F. Stout (new series, Vols. I–III, 1892ff).

Finally, the genetic treatment of consciousness has been advanced mainly by the works of Spencer, "Principles of Psychology" (1855, 3d ed., 1880); Romanes, "The Origin of Human Faculty" (1883, 1888); Morgan, "Animal Life and Intelligence" (1891), and Galton, "Inquiries into Human Faculty" (1883), and "Natural Inheritance" (1889).

II. The Method and Main Divisions of Experimental Psychology.

A. METHOD.

To say that this is the age of science is only to repeat what is now trite, and what no student either of philosophy or of history needs to be told. It is the age of science because it is the age of devotion to science and of results in science. But it is a very different thing to say that this is the age of scientific method. Former ages have seen devotion to science and results in science, but I venture to say that no former age has, as an age, realized a scientific method. So prevailing, however, has the new method now become, and so customary to us, that it is only by historical study that we are able either to see that it is new, or to work ourselves into that degree of intellectual sympathy for the old which the earnest endeavor and unflagging patience of the heroes of philosophy in the past rightfully demand for all time.

In characterizing our time by the word "scientific," as regards method, I mean to say something which is true in philosophy, politics, literature, as well as in the investigation of nature; and to dwell only on the department of thought in which such a method has been, and is, most difficult to realize. In philosophy it is not fully realized; and yet I believe that any class or school of philosophic thinkers who do not face toward the scientific east are steering upcurrent and will be absent when science and philosophy enter a common barge and together compass the universe of knowledge. For it is a part of the same conviction as to scientific method, that neither science nor philosophy will ever succeed in compassing it alone. However painfully this advance may have been won and however loudly the dogmatists may deny its justification, it is sufficient here to signalize the fact that philosophy has in the present half century thrown open her doors to the entrance of critical and empirical methods, and that the results already accruing are evidence of the bigness of her future harvest.

In general philosophy what has been called scientific method is better

known, as I have said above, in a twofold way, as empirical and critical. Retrospectively what we now have to rejoice in in philosophy is due about equally to two traditions, represented by Hume and Kant. The burden of current idealism, as far as it is worthy of consideration in our time, is to purify and conserve the work of Kant. And the burden of empiricism, under the same restriction, is to refute Kant with the only weapons which he himself considered of worthy temper. The battle is drawn at these close quarters and round them both is thrown a common ring of scientific procedure.

In psychology the modern transformation comes most strongly out. Here we find an actual department of knowledge, handed over to a new class of men for treatment, so remarkable is the demand for scientific method. It is no longer sufficient that a psychologist should be familiar with general philosophy and its history, or capable of acute logical criticism of systems; it is necessary, if he would deal successfully with the new problems and gain the ear of the advanced philosophical public, that he should reason from a basis of fact and by an inductive procedure. In short, he must not bring his philosophy, as speculation, into psychology, but must carry his psychology as fact in its connection with physiology, ethnology, etc., into general philosophy.

To illustrate this change, and its effects on general theories, recent discussions of the idea of space may be cited in comparison with its earlier and more speculative treatment. The reasoning of James, Wundt, Bain, and Spencer differ so essentially from the argumentation of Kant and earlier writers that it is almost impossible to find common ground between them. No one among those who accept Kant's results depends in our day very largely upon his reasons; the question is shifted to another field. The physiologist has as much to say about it to-day as the psychologist, and the speculative philosopher must recognize them both.

The whole tendency of the day in philosophy may be expressed by a chemical figure as a "precipitating" tendency. We are endeavoring, and successfully, too, to throw all questions which are capable of such treatment to the bottom as a precipitate—a psychological precipitate—and are then handing them over to the psychologist for positive treatment. As long as our data remained in a solution of ninety parts water (which, being interpreted, means speculation) it was difficult to handle them scientifically. While admitting the utility and necessity of ontology in its place, current psychology claims that its place must be better defined than formerly it has been, and that whenever we can secure a sediment, a residuum, a deposit, apart from a speculative solvent, this is so much gain to positive science and to truth.

One of the ideas which lie at the bottom of the so-called "new psychology" is the idea of measurement. Measurement, determination in quantity and time, is the resource of all developed science, and

as long as such a resource was denied to the psychologist he was called a scientist only in his function of description and classification, not in the more important functions of explanation and construction. And the justification of the application of measurement to psychological facts has come, not from theoretical considerations, for they were all opposed and still are in many of the books of the new idealism, but from practical attempts to do what philosophy declared to be impossible. That is, experiment has been the desired and only reagent. It is true that theoretical justifications are now forthcoming of the application of experiments to consciousness, but they are suggested by the actual results and were not in sufficient currency to hinder the influence of Kant's ultimatum—for example, that a science of psychology was impossible.

By experiment in this connection is meant experiment on the nervous system, with the accompanying modifications it occasions in consciousness. Efforts have been made in earlier times to experiment upon states of consciousness directly. Descartes deserves credit for such efforts, and for the intimation he gives us, in his theory of the emotions, of an approach to mind through the body. But the elevation of such an approach to the place of a recognized psychological method was not possible to Descartes, Kant, or anyone else who lived and theorized before the remarkable advance made in this century in the physiology of the nervous system. And even as it is, many questions which will in the end admit of investigation from the side of the organism are still in abeyance till new light is cast upon obscure processes of the brain and nerves.

A little further reflection will show us that the employment of experiment in this sphere proceeds upon two assumptions which are now generally admitted and are justified as empirical principles, at least, by the results. They are both assumptions which the physical scientist is accustomed to make in dealing with his material, and their statement is sufficient to exhibit their elementary importance, however novel they may sound to those who are accustomed to think and speak of mind as something given to us in entire independence of its organic basis. The first of these assumptions is this, that our mental life is always and everywhere accompanied by a process of nervous change. This is seen to be necessary to any method which involves the passage of mind to body or the reverse by the interpretation of effects. Which is cause and which effect, the mental or the physical change, or whether they both are effects of an unknown cause, is immaterial. To consider such a question would be to introduce what I have called the "speculative solvent." It is sufficient to know that they are always together, and that the change in one may be indicated in symbols which also represent the change in the other. The second assumption is based upon the first, viz, that this connection between mind and body is

uniform. By this is meant what in general induction is called the uniformity of nature. Any relation sufficiently stable to admit of repeated experiment in the manipulation of its terms is in so far uniform. Experiment would be useless if the relation it tends to establish were not stable, since the result of such experiment would give no antecedent likelihood as to the result of others under similar circumstances. Experimental psychology, therefore, rests upon the assumption that a relation of correspondence, be it coexistence or causation, once clearly made out between a mental and a nervous modification, it must hold good under any and every repetition of the same experiment under the same conditions.

These two assumptions made, we have at once the possibility of a physical approach to the facts of consciousness. The result is a relative measurement of such facts in terms of the external stimulation of the nerves, in regular and normal conditions of the activity of attention.

Further, it is apparent that such a means of experimentation may become available either under artificial or under natural conditions, according as the nervous stimulation is due to an external excitation or arises from some unusual condition of the organism itself. All cases of brain or nervous disease, on the one hand, offer opportunities for boundless observation, the unusual manifestations being changes due to the organic disturbances of disease. Here nature has arranged and actually performed the experiment for us; the only difficulty being the physiological one that the cerebral disturbances are as obscure as the mental states which they are used to explain. All such cases of abnormal mental changes, due to internal organic causes, are classed together under the name of physiological psychology. It includes all questions which relate to nerve physiology and pathology, illusion, hallucination, mental disease, hypnotism.

On the other hand, experiments may be arranged for the normal stimulation of the sense organs—skin, muscles, special senses—under artificial conditions as explained in part below. This is experimental psychology. On these lines modern experimental psychology falls into two great departments. As the normal properly precedes the abnormal, it is well to consider the line of researches based upon external experiment, confining ourselves to a more or less cursory view of results of historical interest.

B. PSYCHO-PHYSICS.

In attempting to give a succinct account of some of the results of what I have called experimental psychology, we must forewarn the reader that it is with very modest and, it may be, minor facts that we are concerned. But this is a characteristic of the new method. Any fact in natural science is valuable for its own sake; and it is only after there has been a vast accumulation of such facts that broader prin-

ciples may be inferred from them. The problems we are called upon to consider are such preliminary applications of experiment, and their full value for mental interpretation is only now beginning to be apparent.

I have already stated that the two conceptions of quantity and time, or duration, may be made applicable to facts of consciousness, thus giving us means of relative measurement. According as we are dealing with one or the other conception—according as we are aiming at determination in quantity of sensation, or in the duration of mental states—we may class experiments under two great divisions. All investigations into the quantity or intensity of sensations go to constitute psycho-physics, and all which aim at time determination go to make the department of the science called, formerly, psychometry, now known by the better designation, mental chronometry. Both of these branches of inquiry, it should be borne in mind, deal with the normal consciousness through simple excitations of the sense organs.

Psycho-physics deals with the measurement of the intensity, as it is popularly called—the quantity or mass, as the psychologist uses the words—of sensation. The conception of intensity needs no further explanation; it is simply the difference between the light of one candle and of two or more, the sound of a bell near and far. It is a property of all sensation. The problem which presents itself is to reach a formula for such intensities in terms of the amount of stimulus required at the end organ to produce a given increase or decrease in conscious intensity. To illustrate, suppose a candle illuminates my page to a certain extent, how many candles would illuminate it enough to enable me to see twice as distinctly, or as distinctly at twice the distance? Is there any general law of the ratio of intensity of external stimulus to intensity of internal sensations which will hold good for all the senses? Or is there a different law for each of the different senses? Or, again, is the entire case simply a matter of subjective estimation, varying with the mental and bodily conditions of the individual?

These questions were at one time hotly discussed, but have now been practically answered by the establishment of a single law of relation between stimulus and sensation, which holds good for most of the senses found to be easily accessible, has been partially proved for other classes of sensations, and is under judgment in default of sufficient experimentation for a remaining group of sense experiences. Before entering more particularly into details, however, it is well to define and explain several terms of current use among physiological psychologists.

By "excitation" (or stimulus) is meant the external force which excites a sense organ, whether it be of sufficient intensity to produce a sensation or not. The feeblest sensation which we are able to

experience or feel from any sense is called the "perceptible minimum," the theoretical point at which such a sensation, when further enfeebled, disappears from consciousness, the "threshold" of sensation, and the amount of excitation which is just sufficient for the perceptible minimum of sensation, the "threshold excitation" for that sense. For example, air vibrations are the excitation for sensations of sound, the feeblest sound which it is possible to hear under determined conditions is the perceptible minimum, and the number of units agreed upon—bells, notes, etc.—which are needed to produce this perceptible minimum makes the threshold excitation for this sense. Further, the amount of excitation needed to raise or lower the intensity of a sensation by the smallest amount which can be distinguished and the corresponding difference in the sensation are called the "smallest perceptible difference" in excitation and sensation, respectively. Thus, if one unit be the threshold excitation for sound, and an addition of one-third unit is necessary to produce any perceptible increase in the sensation, then one-third is the smallest perceptible difference of excitation for sound.

With these definitions in mind, we may turn to the problem of finding a law of measurement for intensities of sensation. The preliminary question as to a standard of measurement is already answered in the resort to experiment, viz, the standard must be a scale of excitation values, determined by physical measurement, as pounds, velocities, etc. Given a threshold value of each excitation, we may double, treble it, endeavoring to find some law of increase in the corresponding sensations whereby a corresponding internal scale may be erected. The first step is seen, therefore, to be the discovery of the perceptible minimum of each sense, which may serve as zero point on the sensation scale, its exciting stimulus being the unit point on the excitation scale. This brings the investigator to an actual research on all the sense organs in turn—experiments to determine the minimum of sight, hearing, touch, etc. The methods by which this is done are simple. Any device by which excitation may be lowered or heightened gradually below or above the threshold may serve the purpose. For touch and the muscular sense small balls of cork may be used—differing so slightly in size that when placed, say on the back of the hand in succession, the difference between the last one which is felt and the next which is too light to be felt is as small as possible. By running the series in the reverse order, from weights too small to be felt to others barely felt, and by an equation and average of errors, the point is determined where the excitation produces the smallest perceptible sensation.

As simple as this procedure seems, the conditions are so complicated in some of the senses as to occasion great embarrassment. The eye, for example, is found to have a "natural light" of its own, arising

from mechanical movement, friction or chemical action, from which it is never entirely free, and the smallest perceptible sensation of light must always include this natural factor. The conditions of the body before the experiment also cause great variations, as is seen in experiments on temperature and smell sensations. The threshold value for temperature is much higher or lower, for example, according as the earlier state has been one of higher or lower temperature. The following table exhibits the results of Fechner's experiments on the perceptible minimum:

Perceptible minima.

Touch.....Pressure of 0.002–0.05 gr.
Muscular sense...Contraction of 0.004 mm., right internal muscle of the eye.
Temperature ....1–8° centigrade (normal heat of skin 18.4°).
Sound.....Ball of cork 1.001 gr. falling 0.001 m. on glass, ear distant 91 mm.
Light .....Cast on black velvet by candle distant 8 feet 7 inches.

Space does not permit an examination of each of these determinations, and it is not necessary, for the actual numerical values are not of great importance. The fact that there is a minimum under normal conditions and its determination with sufficient accuracy to give ground for further inferences is all that the theory requires. For that reason I pass on without giving other and later results, even where Fechner has not been confirmed by other experimenters.

So far we have gained two points, i. e., the zero on the sensation scale and the unit value, a positive known quantity from the table above, on the excitation scale. We now cast about for means to graduate both scales in an ascending way by relatively equal values.

It is a common fact of experience that excitations and sensations do not apparently sustain the ordinary relation of cause and effect to each other. Two candles do not illuminate a page twice as much as one; two violins pitched in the same key do not double the sound of one, and as intensities increase it is a matter of ordinary observation that very little variations are brought about by well-marked changes in the stimulus. This result of general observation recurs to us as we advance in the consideration of the values on our scales, for we would expect from this rough judgment of daily life that larger increments would have to be made the higher we ascend on the excitation side to produce regular equal increments on the sensation side.

This is confirmed by a further research undertaken on all the senses in turn, an experimental determination of the amount of increased excitation necessary to produce the smallest perceptible difference in sensations of the same kind. Let us suppose a given excitation for pressure, then increase it slightly until it is judged greater than before, determine the ratio of the increment to the former excitation, repeat the experiment with a much larger excitation, making the same fractional determination, and compare the results. It is found that the fractional

increase in excitation necessary to produce a perceptible difference is constant for each sense. But this means that the absolute increase is not constant, but becomes greater as the intensity of the initial excitation becomes greater. For example, if the initial excitations in two experiments be 6 and 9 grams, a relative fractional increase of one-third would be in one case an absolute increase of 2 and in the other of 3 grams.

There are three general methods of determining the smallest perceptible difference for any sense, due in their formal statement and description to Fechner. I will state these methods briefly in view of their importance in any work of this kind. They are known as the methods (1) of "smallest perceptible differences," (2) of "true and false cases," and (3) of "mean errors." There is a fourth, of especial importance in researches on sight, that of "mean gradations" (Plateau); but it is not necessary to speak of it further. Various modifications of these methods have also been suggested by later writers.

(1) The method of smallest perceptible differences is most direct. It consists in adding to a given excitation until the difference is barely perceived. The difference between the initial and the resulting excitation is the first determination of the quantity required. A plainly perceived difference is then added to the same initial excitation and reduced till no longer perceived. This gives a second determination. The averaging of these two results is the correct value, which we will call DE (difference or differential of excitation). Its ratio to the first excitation is expressed by the fraction $\frac{E}{DE}$. The relative degree of sensibility for any sense, it will be observed, is inversely proportional to the amount of excitation required to give the smallest perceptible difference in sensation, i. e.,

$$S\ (\text{sensibility}) = \frac{DE}{E}.$$

(2) The method of true and false cases consists in comparing two excitations (say weights), the subject of the experiment judging them to be equal or not. The number of true and false judgments is recorded and the ratio between them indicates the approach of the difference of excitation to its minimum value. The relative sensibility again varies as the actual difference between the excitations varies, and also directly as the number of true judgments (in relation to total cases), i. e.,

$$S = E\frac{S}{N}\begin{matrix}(=\text{total cases}).\\(=\text{true cases}).\end{matrix}$$

(3) The method of mean errors consists in comparing two stimuli (weights, etc.) and judging them equal, then in taking their real difference, positive and negative, in a great number of cases, adding these differences without regard to signs, and dividing by the entire number

of cases. The mean error is thus arrived at. The sensibility is inversely proportional to the main error, i. e.,

$$S=\frac{1}{D}\,(=\text{mean error.})$$

Proceeding by one or all of these methods, we establish the smallest perceptible difference of excitation for each of the senses. The following table gives these values as they are now established, subject to revision for certain classes of sensation, especially sight, when the conditions of experiment can be made more free from error:

Smallest perceptible differences.

Touch	1-3
Muscular sense	1-17
Temperature	1-3
Sound	1-3
Light	1-100

The values given, it may be well to repeat, represent the amount of a given excitation which must be added to that excitation to be felt in consciousness. For example, if the eye is already stimulated by a light which represents 1,000 candles, at least 10 candles (a fractional increase of one one-hundredth) must be added to produce any perceptible increase in the intensity of the light. Any number less than 10 could have no effect on consciousness whatever. And so with the relative values given for the other senses.

Now, to revert to the problem which originally concerned us. It will be remembered that the two determinations already arrived at for all the senses are only steps in a process of measuring the intensity of sensations in terms of external stimuli. So far we have determined the smallest perceptible sensation (giving us the starting points on our scale) and the smallest perceptible differences of excitation as we proceed upward in the graduation of our scale. The results of this second research may be stated in general language thus: In order that sensation may increase by successive equal additions, their excitations must increase by a constant fraction of the excitation itself, i. e., by additions which are not equal, but which increase as we ascend the scale of intensities. For example, the successive additions to a sound, to be barely perceived, would require the following series of additions to the stimulus:

$$\tfrac{1}{3},\ \frac{1+\frac{1}{3}}{3},\ \frac{1+\frac{1}{3}+\frac{1+\frac{1}{3}}{3}}{3},\ \text{etc., or } \tfrac{1}{3},\ \tfrac{4}{9},\ \tfrac{13}{27},\ \text{etc.}$$

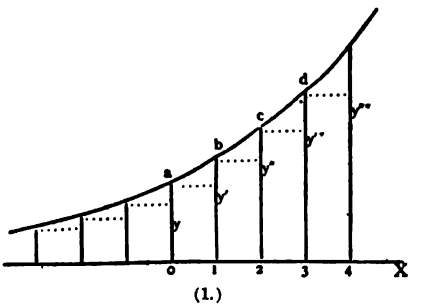
and the actual excitations would be the series:

$$1,\ \tfrac{4}{3},\ \tfrac{16}{9},\ \tfrac{64}{27},\ \text{etc.}$$

This general principle is called the "law of Weber," and may be stated in a variety of ways, of which perhaps the easiest to carry is this: That in order that sensations may increase in intensity in an arith-

metical series, their excitations must increase in a geometrical series. The law may be exhibited in a linear way to the eye in diagram (1):

Let X represent a series of sensations, 0, 1, 2, etc., increasing by a constant quantity from the zero point 0; let the upright lines represent at each point the excitation necessary for the sensation of that intensity. Now, by drawing the dotted lines parallel to X, it is seen that the successive additions made to the vertical are not equal, but grow constantly greater, i. e., for hearing, $y'=y+\frac{y}{3}$, $y''=y'+\frac{y'}{3}$, etc.



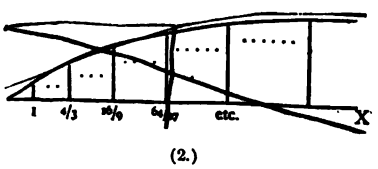
(1.)

Having erected these vertical lines by the law of increase given in the table, the curve a, b, c, d, etc., may be plotted through their extremities, being the "curve of excitation."

The same relation may be shown in an inverse way, in diagram (2) above, in which the scale of increasing excitation is given on the line X, the vertical line representing the sensations increasing by a constant quantity. The curve connecting the extremities is now the "curve of sensation."

A further mathematical expression has been given to this law by Fechner. As we shall see below, it is open to some criticism; yet it is ably defended, and whatever may be its fate as a mathematical deduction, the law of Weber, as given above, will not be involved.

Assuming, says Fechner, that the smallest perceptible differences in sensation are equal for any value of the excitation (an assumption which has no proof), and that very small increments of sensation and excitation are proportional to each other, we may throw Weber's formula into the following equation (DS being increment of sensation, DE increment of excitation, and K merely a proportional constant):



(2.)

$$DS=K.\frac{DE}{E}$$

in which all the quantities have been determined in the tables already given. Now, considering this a differential equation, we may integrate by our calculus and reach the form:

$$S=K.\ \log E, \text{ or}$$

the "sensation varies as the logarithm of the excitation," the celebrated "logarithmic law" of Fechner.

Considered under its more general form, as indicated in the principle of Weber, this law has an unequal application to different sensations. For sight, touch, and hearing, it is fully established; for taste and smell it is still in doubt, by reason of the mechanical difficulties which these senses offer to experimental research. It applies under restrictions to our estimation of linear distance by the eye, to our perception of the passage of small periods of time, and to our discrimination of local positions in the skin. In all cases, however, its application is restricted within upper and lower limits of intensity of sensation. When too intense, the organism fails under the stimulus, reaching the limit of its vibratory responsiveness, and when too faint, either the stimulus does not excite a conscious reaction, or the attention fails to discriminate the sensation.

With so much in the way of exposition of Weber's law before us, it may not be out of place to indicate the principal criticisms which have been urged against it, both in its general result and in the method of research which it involves. To say that it has been criticised is to express very mildly the state of discussion which the last twenty years have seen, especially for a period after the publication of Fechner's great work.

Both of the two assumptions made by Fechner, that the perceptible differences of sensation of the same sense are equal for all intensities of stimulus, and that the increments of sensation and excitation are proportional, are called in question. The results of late physiological work tend strongly in favor of the first assumption and it is probably safely established. The second, with the application of the calculus of differentials, is so plainly subject to criticism that even its strongest advocates only attempt to justify it by the results. Really, it is only infinitely small quantities that we are able to consider differentials or proportional to each other; while by the law of growth, arrived at by Weber, they are shown not to be proportional. This argument, adverse to Fechner's formula, is ably presented by Delboeuf. Another objection is brought, also, to the doctrine of "threshold." It is claimed that there is not a constant threshold for any of the senses, but that the minimum of sensation varies with the condition of the organism, the concentration of attention, etc. If this criticism should be shown, however, to be valid, it would still be possible to establish a table of variations or a coefficient of "personal equation" for individuals, and still preserve the principle of Weber. The objection formerly drawn from the fatigue of the organ under prolonged experiment is now met by the principle called by Fechner the "parallel law;" if we perform the experiments at very close time intervals, we may consider the degree of exhaustion as approximately the same for any two successive excitations. Any modification, therefore, which either excitation undergoes from the element of fatigue is corrected

in the ratio between that and the other excitation. For example, the smallest perceptible difference DA above an excitation A, reached by adding a new excitation B, is expressed by the fraction $\frac{B}{A}$; but any modification which affects both B and A to an equal degree does not alter their ratio.

The objection that Weber's law is as yet of very limited range loses its force in the presence of recent work. The senses to which it applies are the most accessible; but efforts are every day more successful in making the apparatus of experiment available also for the more delicate and involved sensations. It should be remembered that all research involving physiology requires patient and prolonged experiment. Indeed, it is remarkable that so much positive work has already been done in this connection.

The philosophical significance of Weber's law is the ground of main interest. That it is an established law of the relation of the mind and body as respects sensation; that it confirms the general assumption that there is a universal and uniform connection between the mental and the physiological—these points we are constrained to admit, whatever may be our more particular interpretation of the law itself. As to its meaning for our theory of the mind, and whether it has any such meaning, there is more room for difference of opinion, and three distinct interpretations are commonly held among psychologists. Each of these is advanced in answer to the question which Weber's law obviously suggests; i. e., Why is it that the relation of cause and effect does not hold between sensation and excitation; why is sensation proportional to the logarithm of excitation and not to excitation itself?

The first of these interpretations, that of Fechner, is that Weber's law represents the ultimate principle of connection between mind and body; that they are so constituted as to act upon each other in a logarithmic relation. It is of necessary and universal application wherever mind and body are brought into organic connection. In short, on this view the law is strictly psycho-physical. This interpretation has been very generally discredited, principally because it forbids all further research or explanation. Nothing is ultimate which may be explained, and if physical or mental reasons can be given—as the other two theories hold they can—for the disproportion between sensation and stimulus, then the assumption that it is ultimate is gratuitous. Fechner supports his view by two considerations: First, that the physiological theory, as stated below, is inadequate; and, second, that the law holds in cases of nervous exhaustion. The latter point is met by the consideration that in cases of extreme exhaustion the entire series of stimuli is intensified by a given amount throughout, and when the exhaustion is not extreme, it corrects itself by the "parallel law" spoken of above.

Again, it is held, especially by Wundt, that the law is strictly psychological; that is, that the disproportion between sensation and excitation is due to the perception or discrimination of the sensation. On this theory it is not the real sensation which is experimented upon, but perceived sensation; and in the process of taking the sensation up into our apperceptive life it is modified as to its intensity. For example, the single fact of attention to a sensation changes its intensity; what effect might not the act of directing the mind to it, as is required in the above experiments, have upon it? In answer to this interpretation it may be said that it can never be critically established, since we have no means of getting at the true worth of sensation except as it is interpreted in our attentive consciousness. By "intensity" we mean intensity to us, in our intellectual life, and to speak of the intensity of sensations in a relative way, apart from the apperception and comparison of them, is to become unintelligible. Wundt, however, has an ulterior end in view—the support of his doctrine of apperception—and he himself admits that he would not exclude the physiological interpretation.

The third interpretation, which is probably the true one, makes the disproportion spoken of purely physiological. According to the advocates of this theory, the law of cause and effect does hold in this case, as in others, but a part of the internal cause is lost in the transmission by the nerves, so that the true excitation at the brain center is less than at the peripheral organ, and is in direct proportion to the intensity of the sensation which it causes. Briefly stated, the following facts tend to support this view: (1) The phenomenon of nervous arrest would lead us to expect a diminution of the stimulus between the organ and the brain; (2) nerve action is dissipated in heat; (3) force is lost in the exciting of the internal organ; hence, by analogy, we would expect the same in the stimulation of the centers; (4) the general parallel between electricity and nerve action would indicate resistance to be overcome in the one case as in the other; (5) on general grounds a loss of force may be expected in an extended or complicated mechanism.

While not expressing a dogmatic opinion, yet a decided preference for the last view seems justified by the facts, although Wundt has been recently reenforced by reliable results.

With this hasty and imperfect exposition, the recent work technically known as Psycho-physics may be left. I now turn to the second great class of problems which arise from external experiment; i. e., those which are concerned with the duration of mental states.

C. MENTAL CHRONOMETRY.

It is only within the last thirty years that anything like exact and scientific efforts have been made to measure the time or duration of

mental states. The necessity of some such measurement first arose in astronomy, where the most exact determinations of transit and other periods must be made. A source of error in such observations was early seen to be time taken up by the transmission of the excitation of the retina to the brain and the time taken by the impulse given to the hand to record the event to travel from the brain to the hand. This element of personal equation in astronomical work is elevated to a distinct problem in psychology, and its conditions are extended to include all mental states which have the physical basis necessary to the employment of physiological experiment. We therefore have a "science of the duration of mental states."

Before the rise of experiment in this connection, desultory treatment had been given to the comparative rapidity or slowness of our "ideas"—such questions as to whether all "ideas" were successive or some simultaneous, speculations on the cause of the rapidity of dreams, etc. But being only general descriptions of fact, and depending on individual experience and testimony, such observations were almost useless in general mental theory. With the positive work now done, it is quite astonishing how many side lights are thrown on other questions and to what unexpected uses time determinations may be put.

Proceeding on the assumption already made and established in psycho-physics, we observe that any period of time which is occupied jointly by a physiological and a mental process, and which may be recorded by movements traced by a time-registering apparatus, will involve as one of its factors the time of the mental process considered for itself. If, then, we have means of measuring the time taken by the physiological process alone, we may by subtraction find the mental time. Now these conditions are realized in every instance in which we perform a movement in response or reaction to a sensation from without. For example, suppose I hear a word and then write it; the sensation of sound is the central link in a chain of nervous processes beginning in the ear and ending in the hand. From the ear the stimulus is transmitted to the brain, and from the brain the command to move is carried to the hand; between these two processes the third or mental fact, sensation and volition, has taken place. Now such a chain of events involving any sensation and movement, and a conscious event connecting them, is called a "simple reaction," and the time that it takes the "simple reaction time." The determination of this time is the first problem.

The simple reaction time is determined for any sense with its reaction in movement (for example, a sound and consequent movement of the right hand) by connecting the hand movement with a very delicate clock (chronoscope or chronograph) in such a way that there is an instantaneous stoppage of the clock upon the movement of the hand.

This is arranged by directing the person experimented upon to press an electric button when he hears a signal (say a bell stroke). Now let the bell stroke emanate from the clock as it reaches a certain indication upon its dial, and our experiment is ready for trial. The experimenter stands ready to press the button; the bell sounds; he presses; the clock stops. The dial face now indicates the time which elapsed between the actual sound of the bell and the movement of the hand. Now, calling the time taken up by the nervous process from the brain to the hand "motor time" (M), and the time of the mental event between them, "perception time" (P), we can express the simple reaction time (R) in this equation:

$$(1)\quad R=S+P+M,$$

in which S and M are purely physiological.

This determination has been made by a great number of observers upon three of the senses, sight, hearing, and touch, with remarkable uniformity of result. It varies with different classes of sensations and individuals from one-eighth to one-fifth second.

Recent experiments of Helmholtz and Dubois-Reymond have determined approximately the velocity of both sensor and motor nerve transmissions, so that we may substitute known values for S and M in the formula given above, as follows:

$S+P+M=.15$ sec. (about).
$S+M=.06$ sec. (about).
$P=.09$ sec. (about).

The word "about" indicates variations for the different senses. For all the senses the general law will hold that the purely physiological time (S+M) is less than half of the entire reaction time.

Having the simple reaction experiment arranged, we may vary the conditions in a variety of ways and thus arrive at the most favorable mental attitudes for quick reactions. In the simple experiment the excitation (sound, above) was expected, but the exact amount of its occurrence was not known. If this exact moment is given to the "subject" by a preliminary signal the reaction time is diminished. Again, if neither the kind of excitation nor the time of its occurrence is known, the time is greatly increased. From these two variations we gather that the state of the attention has a great influence upon the reaction. As we would expect from our ordinary experience, when the attention is taken unawares a longer time is required to respond actively to external influences.

Another exceedingly important influence is practice. This is due to the artificial conditions of all experiment and the increased facility we acquire by personal adjustment. We react a thousand times daily under less artificial circumstances, and since the reaction time is diminished by practice, it is probable that our customary habitual

responses to stimuli of sense are more quickly performed than the most favorable experiments would indicate.

Having now reached what may be called the "mental" time (P) the question arises, How is this to be divided between the perception or apprehension of the sensation and the volition to respond by movement? Two methods of experiment have been devised for breaking up this period into its elements. The first consists in experimenting on cases of very close physical association, as between hearing and speech, right hand and foot, etc., where the reaction is almost automatic and the will element is practically ruled out. The subject agrees beforehand to repeat any familiar word spoken to him as soon as he hears it. Experiments of this kind led Donders and Jaager to the following principle: The relative times of perception and volition depend upon the degree of physiological association between the receiving and reacting organs; when this association is close the mental time is largely taken up with the perception; when loose it is nearly all occupied with volition.

The other method, that of Wundt and Baxt, consists in repeating the excitation one or more times before the voluntary impulse for the reaction is given. Thus the perception element is repeated and the difference between this time and the simple reaction time is the time due to the additional act of perception. For example, let two equal and moderate excitations, say bell strokes, follow each other quickly, the reaction being made only after the second; we then have the equation (here p represents the perception of the first stroke, which carried no volition with it):

$$(2)\quad R'=S+p+P+M.$$

Now, repeating the experiment with only one stroke, we have as before:

$$(1)\quad R=S+P+M.$$

Subtracting (1) from (2) we have:

$$R'-R=p.$$

Here R' and R are readings from the clock. This gives a numerical determination for p. The volition time will then be P−p.

From this latter experiment a curious result follows if the successive excitations are of very different intensities. If the more intense really follows, it is, nevertheless, heard first, and the less intense, really first, follows after; or they may appear to be simultaneous though really successive. This is the case in general whenever the attention is strongly drawn to the second stimulus and follows from the principle already spoken of, that the attention, when concentrated, diminishes the reaction time. This will be the case in general whenever the diminution in the reaction time of the second exceeds the real interval between the two. The same phenomenon is experi-

enced often when one is awakened by a loud noise. He hears the noise after he awakes though it was the noise that awaked him. It simply means that because of the dormancy or preoccupation in dreamland, the reaction time of the sound is lengthened into his waking consciousness, while the shock to the nervous apparatus was sufficient to rouse him from sleep. This shows also the dependence of the order of associated states of memory upon the movements of attention in the first experience rather than upon the order of external events. The fact is also important in astronomical observation; a new excitation to the eye, such as the appearance of an expected star on the meridian, is anticipated by the attention and given a reaction earlier than its true position would confirm.

The distinction between perception and reproduction—that is, between the conscious form of a presentation and that of a memory picture—is very artificial, inasmuch as reproduced images enter in all our perceptions and influence their time. I have dealt heretofore with simple perception as if this influence did not exist, but a moment's reflection shows that it should be taken into account in all time measurements. In the experiments of which I have spoken, in which attention plays a part—that is, in which the subject knew, before he experienced the excitation, its nature and quality—the reaction time was diminished, for the reason that it was possible to call up a memory picture of previous experiences and hold it before the attention in such a way that the voluntary impulse could be set in play almost immediately upon the discharge of the sensor centers. For example, if the subject expects the stroke of a bell, he recalls the sensation of a previously heard stroke, and the organs are in readiness to respond. So what I have called perception time really results from a diminution due to reproduction. The true time for perception must be obtained by experimenting with excitations entirely unexpected, and the differences between the reaction time in this case and that of an expected excitation of the same nature due to the influence of reproduction simply is sometimes half the true perception time.

The problem then arises to determine the reproduction or simple association time; that is, the time which elapses between the full perception of a first image and that of a second which the first suggests. To do this, we must first determine the time of a complete association reaction; that is, the time which elapses from (say) the hearing of a word, as storm, and the utterance of a closely associated word, as wind. The association must be spontaneous with the subject, and the original word a monosyllable and very familiar. The uniformity of result is surprising, considering the variety and indefiniteness of our customary associations. Our equation is now (A representing the new element due to association):

$$(3)\quad R' = S + P + A + M.$$

Reacting again for the word alone without the associated image, we have

$$(1)\ R=S+P+M.$$

By subtraction, $A=R'-R$, hence value for A.

The average of experiments gives this value about three-fourths–four-fifths second.

These results hold only for close associations established by long habit, especially those dating back to childhood or early life. A third process upon which experiment has been employed is that of discernment; that is, the act of distinguishing between given images and indicating the distinction by choice. The excitation, say a red light, is agreed upon and is exhibited to the subject indiscriminately with another, say a blue; the subject to react only when he sees the red. In this process, it is seen, two intellectual acts occur: (1) Comparison of the visible light with the reproduced image in consciousness; (2) a judgment as to their identity or nonidentity, and these imply (3) the act, first of all, of simple perception, and (4), last of all, the act of volition, as in preceding cases. Letting D represent the whole distinction time, we have:

$$(4)\ R'=S+P+D+M.$$

Now reacting simply:

$$(1)\ R=S-P-M.$$

By subtraction, $D=R'-R$.

Thus arrived at, the time of distinction is found to be for two indiscriminate stimuli, one-twentieth–one-tenth second. I say for two stimuli, for the time is lengthened, as we would expect, when the possible choices are increased. For example, if we use three lights, red, blue, and green, the time occupied in a true discrimination is longer, and it increases geometrically. Wundt experimented with the letters of the German alphabet, and Cattell with both English and German printed characters. Cattell finds that it takes about one-half second to see and name a single letter, and that it takes longer to distinguish the German characters than the English.

The time of the judgment also has entered into all our measurements heretofore, and it is impossible to isolate it as a distinct intellectual act for the purpose of experiment. As an act in time it can be viewed only in particular cases and under prescribed conditions, and even then the time is to be considered relatively to that of other processes necessarily involved.

Trautscholt has studied the time of the "judgment of subordination" from genus to species. A word is spoken and the subject reacts as he conceives a word in logical subordination to the given concept; for example, animal–dog. An element of association which it is impossible to eliminate enters largely here. By the same process as before we find the value of J (judgment) from the equation of the

entire reaction to be about 1 second. That is slightly longer than that of the simple association. It varies also with the specific quantity of the logical terms; that is, (1) the time is longest when the subject is abstract and the predicate a more general notion (virtue–honesty); (2) shortest when the subject is concrete and the predicate particular (hound–Bruno).

Besides these and other positive results additional important contributions to psychological science have been made. It may be well, in closing, to indicate some of its more general bearings of these time measurements.

The influence of the attention already mentioned is now found to be itself variable and subject to experiment. The most constant variation arises according as the attention is given to the "receiving" or to the "reacting" sense, giving respectively the "sensorial" reaction (longer) and the "muscular" reaction (shorter). The relation of these two kinds of reaction to each other has recently been found to vary with the habits of attention of the particular person experimented with.

All this work has tended to the emphasizing and defining of the voluntary side of the mind, as given in acts of the attention. The results here alone more than pay for the entire work the researches involve. That the will is to-day the question of capital importance both in psychology and general philosophy, and that philosophers are hopeful and expectant of results in the theory of our active life as never before under the lead of speculation, is largely due, I think, to the new psychology. The experimental work described above has cleared up the problem of the attention in many of its conditions; its relation to the time-sense and the origin of the idea of time, its inseparable connection with muscular activity, its bearing upon intensities everywhere in mental experience, its influence in our perception of the external world and of space. Indeed, one can not arise from the study of experimental psychology, as it now spreads out before us its data, without the overwhelming conviction that it is upon the theory of mental effort in attention with feelings of resistance that the general psychology of the future will be concerned.

Again, such experiments show both the isolated character of mental states in their dependence on physiological states, and at the same time the clear necessity of a circumscribing, grouping, and arranging consciousness of which they are states; a unity and individual active self, which the manipulation of single states does not impair. In dealing with what I have called internal psychology as open to experiment, viz, abnormal and diseased states of mind, this question of unity and personality becomes an open one; but from the work now spoken of we have the emphatic emphasis of a principle of activity by which alone single, successive, or simultaneous states have any meaning or significance in our mental life.

III. The Exhibits in Psychology.

We are now prepared to consider the exhibits made in the interests of experimental psychology at the Columbian Exposition. It is evident that departments in which progress is in the main abstract and immaterial—such as the social, moral, and theoretical sciences—can not show their work to the eye, and so have heretofore appeared at the world's great expositions only as their results have been embodied in more practical life in education and in institutions. It is, however, unfortunate that this should be so; for the more ideal and spiritual aspects of a nation's life are just the aspects in which popular instruction is defective, and these are the aspects which should, least of all, be omitted in a survey of the conditions of present-day civilization. Yet it is so; and it becomes easy to see, therefore, that it is only as psychology has become experimental, and so has found it possible to state her problems and results to a degree in forms which allow of diagrammatic and material representation, that she is able to "exhibit" herself. What psychology showed, therefore, at the Chicago Exposition was the experimental side, as I have sketched its problems and methods in what precedes.

The exhibits bearing on psychology in its scientific aspects—as apart from the educational aspects of which I speak later on—may be placed in order thus:

(A) A collected exhibit made by the department of anthropology, of which Prof. F. W. Putnam, of Harvard University, was chief, under the immediate direction of Prof. Joseph Jastrow, of the University of Wisconsin, consisting of a psychological laboratory in operation, with all its accessories.

(B) A collection of instruments shown in the German educational exhibit under the heading, "Psychophysics."

(C) Instruments shown in the general exhibit of the "Deutsche Gesellschaft für Mechanik und Optik."

(D) The private exhibits of particular instrument makers.

(E) Exhibits made by single universities, i. e., those by the University of Pennsylvania and the University of Illinois.

I may consider these briefly in order.

A. The laboratory for experimental psychology gathered by the department of anthropology (ethnology).

This laboratory constitutes the first attempt ever made to exhibit at an international fair the state of progress of the world in this branch. When taken in connection with the other laboratories exhibited by this department, i. e., in anthropology and neurology, it may be accepted, in its main features, as an adequate historical index of the psychological progress of the nineteenth century. The general fea-

tures of the working laboratory can not be better described than in the words of the director, Prof. Joseph Jastrow:*

THE PSYCHOLOGICAL LABORATORY.

The object of this laboratory is to illustrate the methods of testing the range, accuracy, and nature of the more elementary mental powers, and to collect material for the further study of the factors that influence the development of these powers, their normal and abnormal distribution, and their correlation with one another. The laboratory is thus designed, not as are those connected with universities, for special research, or for demonstrations and instruction in psychology, but as a laboratory for the collection of tests. As in physical anthropometry the chief proportions of the human body are systematically measured, so in mental anthropometry the fundamental modes of action upon which mental life is conditioned are subjected to a careful examination. In both cases the first object is to ascertain the normal distribution of the quality measured. With this determined, each individual can find his place upon the chart or curve for each form of test, and from a series of such comparisons obtain a significant estimate of his proficiencies and deficiencies. It should not be overlooked that mental tests of this kind are burdened with difficulties from which physical measurements are comparatively free. Our mental powers are subject to many variations and fluctuations. The novelty of the test often distracts from the best exercise of the faculty tested, so that a very brief period of practice might produce a more constant and significant result. Fatigue and one's physical condition are also important causes of variation. It is impossible in the environment of the present laboratory to secure the necessary time and facilities for minimizing these objections. They detract more from the value of an individual record than from that of the combined statistical result. So much remains to be done in this line of investigation that at every step interesting problems are left unanswered. But what has been done emphasizes the importance and probable value of further research. The problems to be considered when once the normal capacity has been ascertained are such general ones as the growth and development with age of various powers; what types of faculty develop earlier, and what later; how far their growth is conditioned upon age, and how far upon education; again, the difference between the sexes at various ages, differences of race, environments, and social status are likewise to be determined. The relation of physical development to mental, the correlation of one form of mental faculty with others, the effect of a special training, these, together with their many practical applications, form the more conspicuous problems to the elucidation of which such tests as are here taken will contribute. In addition to the interest in his or her own record, the individual has thus the satisfaction of contributing to a general statistical result.

THE SERIES OF TESTS.

The apparatus is arranged on a series of tables, the attendant directing the test from his place in back of them, while the subject, as a rule, is seated upon a chair placed between the tables. A railing separates the attendant and subject from those who may be observing the tests. Beginning on the left of the entrance from the aisle, the tests are arranged as follows:

Table No. 1.

Judgment of lengths by finger movements.—Five bars with terminal stops are arranged horizontally, the one above and a little behind the other; the subject passes his forefinger to and fro along these bars and so forms a judgment of their relative length. He indicates his result by placing a peg, bearing a number "5," in a hole on the bar which he regards as the longest, a "1" on the shortest, and "2," "3," and "4"

*Official Catalogue of Exhibits, Department M.

correspondingly. Having thus arranged the one series of lengths in what he determines to be the true order, the apparatus is reversed and another series with smaller differences is presented for arrangement in order. The sensibility involved in this test is the information obtained from the sensation accompanying the contraction of the muscles. The result is recorded in each case as correct or as involving a certain degree of error. The true lengths are 150, 165, 181.5, 199.7, 219.6 (a ratio of increase of one-tenth) for the coarse series; and 150, 157.5, 165.4, 173.6, 182.3 (a ratio of increase of one-twentieth) for the fine series. The apparatus is entirely screened so that the bars are never seen.

This method of arranging in order a coarse and a fine series of five stimuli has been adopted in several of the tests on account of its advantage of combining a large number of comparisons in one result and of permitting the subject to make his own record at his own convenience.

Judgment of weights.—A series of five weighted hard-rubber boxes, differing in weight, are presented and the subject required to arrange them in order of weight. The weights are held and raised between the thumb and forefinger, the sensibility involved being the combined pressure sense of the skin and the sense of resistance overcome by the contraction of the muscles in raising the weights. Two series of weights are used, the coarse weighing 300, 320, 341.3, 364.1, 388.4 grams (a ratio of increase of one-fifteenth); and the finer, 300, 310, 320.3, 331, 342 grams (a ratio of increase of one-thirtieth).

Touch.—The minimal distance is determined for the tip of the forefinger between the points that can just be felt as two. This form of sensibility differs greatly in different portions of the body; points separated by one twenty-fifth or one-fiftieth of an inch can be felt as two on the tip of the tongue, while on the back of the neck they may be separated by three-fourths of an inch and yet be felt as one. A series of fixed points are used, varying by half millimeters up from 5 to 6 mm., and a result quickly reached. The points are necessarily applied at precisely the same moment and with a constant and known pressure.

Table No. 2.

Judgment of surfaces by feeling.—A series of surfaces (about 3 inches square) are formed by winding wires of various diameters tightly around an iron form. Each turn of the wire rests close against the neighboring ones, so that a more or less rough or smooth surface is formed according to the grade of wire used. The subject places the forefinger of his right hand successively through five openings in a screen, by which the surfaces are hidden from view, and feels the surfaces by passing the tip of the forefinger to and fro across it. Having estimated their relative roughness and smoothness he places a peg bearing a "5" over the coarsest surface, a "1" over the finest and the others accordingly. The sensibility involved is a form of active touch similar to that used in judging the texture of cloths, metals, etc. A coarse and a fine series are used, the wires having diameters of 0.051, 0.064, 0.081, 0.102, and 0.128 inches (a ratio of increase of one-fourth) in the one series; and 0.051, 0.057, 0.064, 0.072, 0.081 inches (a ratio of increase of one-eighth) in the other series.

Rapidity of movement.—The subject touches an electric key as quickly as possible, each closing of the circuit being automatically recorded. In this way a record is taken of the maximum number of finger movements that the subject can make in 15 seconds. The wrist is held in order to insure an isolated and uniform finger movement.

Sensitiveness to pain.—A gradually increasing pressure is brought to bear upon the tip of the forefinger of the left hand, and the subject is asked to indicate the moment at which the pressure first becomes at all painful. This lower limit of pain is recorded to the nearest one-fourth of a kilogram (1 kgm. = 2.2 lbs.) by means of a coiled-spring indicator. Three records are taken. (This apparatus is designed by Professor Cattell, of Columbia College.)

Table No. 3.

Equality of movements.—The subject places the point of a lead pencil at the left end of a sheet of paper 15 inches long, and makes five movements by raising the pencil and bringing it down again, the attempt being to make the distance between the dots so recorded equal. The test is made with the eyes closed, the estimate of the distance moved depending upon the motor sensibility. The only limit of movement is that suggested by the length of the paper. The average distance between the dots and the average percentage of deviation are computed and recorded.

Reproduction of lines.—Three lines, approximately 1, 2, and 3 inches in length, are shown one at a time. The line is removed and the subject immediately thereupon draws a line as nearly as possible of the same length as the one just seen. The amount and direction of error of each reproduction is recorded.

Accuracy of aim.—The subject attempts to touch with a hard-rubber pencil a small cross printed on a sheet of paper (3 inches square) and placed upon the table about 18 inches away. The error—i. e., the distance between the center of the cross and the point actually touched—is recorded by means of carbon paper upon a sheet beneath. The subject is thus prevented from seeing his error, while a circular screen upon the pencil hides the cross a little before the point approaches it and thus insures a direct and uniform movement. The subject attempts to strike the cross ten times, and the direction and amount of each error is noted.

Division of lengths.—The apparatus (devised by Professor Münsterburg, of Harvard University) consists of a surface of black felt, about 20 inches long, with three adjustable white strips for dividing off the surface. The strips at each end are set to form a constant distance (in the present test 40 cm. = 10.2 inches), and the subject's task consists in setting the middle strips so as to divide the distance exactly in two; or, again, to mark off one-third of the distance. A scale may be quickly turned into position and the error noted.

Right and left movements.—The subject places the forefinger of each hand upon the center of a wire and simultaneously moves the fingers out to an equal distance in opposite directions. By means of the buttons left at the ends of the movements and a scale the difference in the extent of movement of the hands is determined. In this test right and left handedness plays an important part. The instrument was designed by Dr. Fitz, of Harvard University.

Table No. 4.

Accuracy of movements.—Starting at the center of a sheet of paper 12 inches square, the subject draws a line as accurately as possible, first toward a point at the edge of the sheet to the left, then to the right, then above, and then below. The starting point and the four other points are marked by crosses. To prevent the natural retardation of the movement as the pencil approaches the cross a small circular screen is placed upon the pencil. The error and general directness of the movement are recorded. This test, like the accuracy of aim and reproduction of movements, involves the guidance of movements by the eye.

Judgments of lengths by sight.—By pressing one or another of five keys, five cards appear bearing lines of different lengths. The subject judges the relative lengths of the line, and indicates his judgment by placing a peg bearing the number "5" upon the key that brings up the longest line, a "1" on the shortest, and so on. The apparatus is then reversed, and a second series of five lines with smaller differences presented for judgment. The lines in the coarse series are 2.00, 2.10, 2.20, 2.31, and 2.43 inches in length (a ratio of increase of 1-20), and in the fine series 2.00, 2.05, 2.10, 2.15, and 2.21 inches (a ratio of increase of 1-40).

Estimation of lengths in four directions.—The upper arm of a cross printed upon a sheet of paper 8 inches square bears a small mark 50 mm. from the center. The subject attempts to place a mark upon the other three arms at an equal distance from

the center. The divergences from 50 mm. are then measured to the nearest half millimeter. The arms of the cross are unequal, and are symmetrically placed in order to insure judgment of length from the center outward.

Form alphabet.—This name is given to a series of twenty-five characters, each consisting of a verticle stroke and two horizontal strokes, one above and one below. The horizontal strokes are either both long or both short, to the right or left, or long on one side and short on the other. Twenty-five typical variations have been detected, and one of these singled out as the form to be identified. Over two hundred of these forms are arranged in a chance order upon a sheet 8.5 inches square, with the form to be identified clearly indicated at the top. The subject finds and marks off as rapidly as possible as many of the forms exactly like the one designated as he can recognize within the time allowed, ninety seconds. The number correctly and the number incorrectly marked are recorded. The test involves the power of rapidly distinguishing between small differences in length, position, and form.

Table No. 5.

Quickness of perception.—Behind a photographic shutter there appears for a brief moment (about one-twentieth of a second) a card bearing a series of black dots, or dots of different colors, or words, etc. The subject attempts to determine the number and color of the dots and to read the words within brief period of exposure. From the correctness of the answers given the quickness of perception is estimated.

Memory.—A series of printed words, numbers, etc., appears successively behind an opening in a screen; as soon as the series is completed the subject attempts to write as many as possible of the words or numbers in their proper order. The number correctly recalled with and without regard to order are recorded as an indication of the range of memory, or "memory span."

Reproduction of lengths by memory.—In a former test (Table No. 3) the subject drew lines as nearly as possible of the same lengths as three pattern lines shown. He now draws these lines again according to his recollection of them. The increase of error is due to the fading of the sense image in the memory.

Table No. 6.

Location reaction.—A white spot upon a metal strip may be placed at any portion of about one-sixth of the circumference of a circular track (diameter about 36 inches). The spot is concealed by a screen, the falling of which is the signal for the subject to find and touch the spot as accurately and quickly as he can. The fall of the screen starts and the touching of the spot stops the swing of a pendulum-chronoscope. The time is thus measured to the nearest one one-hundredth of a second and the error in position to the nearest millimeter. (This apparatus was designed by Dr. Fitz, of Harvard University.)

Table No. 7—Reactions.

Simple reactions: Touch, hearing, sight.—The time to be measured is that elapsing between the presentation of a stimulus and the indication by the subject that the resulting sensation has been received. The subject receives a tap on the back of the hand, hears the stroke of a bell or sees a white spot in back of a falling screen; the same movement that produces the touch, the sound, or the fall of the screen starts an electric chronoscope registering one-hundredths of a second. The reaction consists in touching a key, which instantly stops the hands of the chronoscope.

Complex reactions: Choice of two touches.—The right or the left shoulder of the subject is touched, and as quickly as possible he touches a key with his right hand if the touch has been on the right shoulder; with the left hand if upon the left shoulder. The increase of time above the simple reaction is that needed for determining the place of the stimulus and for choosing the proper movement.

Choice of five numbers and movements.—The stimuli are the five numbers, 1, 2, 3, 4, 5, exposed by the falling of the screen; and the reaction, the touching of the particular one of the five keys bearing the number exposed. The time measured is that needed for reading the number and choosing the proper one of five movements.

The apparatus is also arranged for the determination of the time of a variety of mental processes, such as color distinction, naming pictures, reading, adding, classifying, association, etc.

In all tests several records are made. These time movements are important as a test of general mental alertness, and as a means of studying mental processes not readily susceptible of measurement by the usual methods.

Copying test.—The time needed for writing ten given short words from a printed copy is measured to the nearest second.

Association test.—The time needed for thinking of and writing down an association to each of ten given words is measured. The difference in time between this and the preceding test gives some indication of the readiness of association.

Picture and word test.—The rapidity with which a given ten words or pictures can be found amongst forty is measured. This time serves as an index of general mental alertness, and also gauges the closeness of association between word and picture. The test is further arranged to yield some indication of memory, first, as the power to recall, and secondly, as the power to recognize. First, the subject attempts, after a given interval, to write as many of the forty words or pictures as he can recall; and then he attempts to mark off on a sheet containing sixty pictures or words in irregular order (the original forty and twenty others) as many as he can recognize as having seen on the former sheet. The number of pictures or words correctly recalled and correctly recognized gauges the capacity of this form of memory, while the time needed for the various stages of the test gives a further useful indication.

OPTICAL TESTS.

On the west walls, to the rear of tables 6 and 7, are arranged a series of tests of the range and accuracy of form and color vision.

Range of vision.—The subject views, at a distance of 5 meters (16.4 feet), a card bearing in proper sizes a series of rings, either complete or open at one or two places to the left, right, above, or below. He is given a blank, spaced off like the large card, and draws the forms in their proper places as well as he can. All naming or reading is thus avoided, while the smallest set of circles correctly drawn determines the range of vision. The sizes extend from 30 to 2.5 diopters. (The execution of this test is due to Dr. C. A. Oliver, of Philadelphia, Pa.)

Accuracy of vision.—Groups of dots of various sizes 40 to 2.5 diopters are viewed at a distance of 5 meters, the subject counting the number of dots in each group. The smallest size of dot correctly counted indicates the accuracy of vision.

Color sense.—A series of 28 circular patches of color are arranged in their spectral order around the circumference of a large black disk. These colors are indicated by numbers from 1 to 28. Through a circular opening at the center of the large disk any one of ten colors may be made to appear; each central color is indicated by a letter, A, B, C, etc. The test consists in matching successively each of the ten central colors with one at the circumference. This the subject does as rapidly as possible; the nature of the error is an indication of defects of color vision, while the time furnishes an index of the development of the color sense.

Shade.—Nine shades of gray are arranged upon a board, not in the order of their intensity, and are indicated by numbers. Then one of the shades is shown singly and the subject attempts to identify it by its number. The number and the nature of the errors gauge his ability to see slight distinctions of shade.

In addition to these tests of which systematic records are made, there are tests of

the confusion of colors, singly and in pairs; preference of proportions, and other tests which can not be further described.

Demonstration table.—Upon a long table near the east wall are shown some pieces of apparatus and materials illustrating a few typical principles in the study of sensation. Among the points demonstrated may be mentioned, color contrast, color mixture, subjective colors, duration of the after image, stereoscopic combinations, double images, retinal rivalry, peripheral vision, blind spot, estimation of size, visual interpretation, contrast of extent and intensity of pressure, upper and lower limit of audibility, etc.

Charts, curves, etc.—Along the west wall and portions of the east wall are arranged a series of curves representing in graphic form the result of investigations of various sensory, motor, and mental faculties. The largest group is devoted to sets of curves showing the results of tests, many of them the same as those taken in the laboratory, and all of similar purpose. These results are based upon tests taken at nine different colleges, upon 850 persons, with college students predominating. They represent the normal accuracy and distribution of certain forms of sense and motor capacity and mental powers, and the nature of the error when a constant error is involved. Other groups of curves illustrate the results of research upon the relation between mind and body, on memory, illusions, involuntary movements, reaction times, association, etc.

Photographs of psychological laboratories.—Upon the south wall and adjoining portions of the east and west walls the chief psychological laboratories of this and other countries are represented by photographs. This collection gives a general view of the extensive material provisions that have been made for the further development and teaching of experimental psychology. The photographs are accompanied by outlines of courses of study in psychology. The foreign universities represented are Bonn, Geneva, Paris, Prague, Rome, Tokyo; the American are Brown, Clark, Columbia, Cornell, Harvard, Illinois, Pennsylvania, Princeton, Toronto, Wellesley, Wisconsin, and Yale.

The material contained in this laboratory has been collected by the section of psychology of the department of ethnology, with the aid of the psychological department of the University of Wisconsin. With the exceptions already noted, the apparatus has been prepared and in most cases designed for the use of this laboratory.

The electrical supplies are exhibited by the Ansonia Electrical Company; the shutter used upon table No. 5 is exhibited by the Bausch & Lomb Optical Company, Rochester, N. Y.

APPARATUS ROOM.

The collection of apparatus aims to exemplify the chief forms of apparatus and material used in special research and general study of mental phenomena. Some of this apparatus is used as well by physiologists, physicists, and physicians, but the greater portion has been designed especially for psychological purposes.

The apparatus has been collected by the section of psychology of the department of ethnology, the chief contributors being the psychological departments of the following universities: Brown, Harvard, Pennsylvania, Toronto, Wisconsin. The following instrument makers: Cambridge Scientific Instrument Company, Cambridge, England; H. Elibs, Freiburg, Germany; R. Jung, Heidelberg, Germany; J. D. Kagenaar, Utrecht, Holland; M. Kohl, Chemnitz, Germany; C. Krille, Leipzig, Germany; F. Mayer, Strassburg, Germany; W. Petzold, Leipzig, Germany; R. Rothe, Prague, Austria; E. S. Stohrer Leipzig, Germany; Ch. Verdin, Paris, France; Milton-Bradley Company, Springfield, Mass.; Ganun & Parsons, New York; Meyrowitz Brothers, New York; Queen & Co., Philadelphia; E. S. Ritchie & Sons, Boston; Yarnall, Philadelphia, together with a number of individual exhibitors.

The apparatus is classified throughout according to the purposes for which it is

used, and each bears a label explaining its mode of use and acknowledging its source. There are ten cases of apparatus, the contents of which are indicated as (beginning upon the left of the entrance from the aisle) touch; the eye light and form sense; color sense; binocular vision (in lower case, color contrast); hearing (in lower case, visual inferences; movement (in lower case optical illusions); recording apparatus; time-measuring apparatus; reaction-time accessories.

In addition there are arranged upon platforms in the center of the room and near the north wall, as well as on the tops of the cases, a miscellaneous series of apparatus too large to be exhibited in the cases.

Touch.—What is properly termed touch includes a group of sensibilities connected with the skin. The chief of these are the form and space sense of the skin, sense of pressure, sense of temperature, and the sensations accompanying muscular contraction. The form sense is most usually tested by æsthesiometers, which determine the smallest distance between two points that may be felt as two, this distance differing widely in different portions of the body. A variety of designs of such apparatus is exhibited. Another group of instruments have for their object the determination of the smallest outline and solid shapes that may be distinguished when placed upon the skin; of the slightest differences in texture and in thickness that can be felt; of the perception of movement upon the skin; of the relation between lengths as judged by the skin and by the eye; of the combinations of touch impressions, and the like.

As types of apparatus for the study of the pressure sense, test weights and special forms of pressure balances are exhibited. These are used to determine the smallest differences in weight that can be perceived under various circumstances. The temperature sense is represented by simple devices for locating and mapping the hot and cold spots, or the special points of the skin specially sensitive to heat or cold. A number of devices for studying the extent and accuracy of the sense of movement completes the inventory of this case.

The eye light and form sense.—As the processes of seeing are most directly related to the structure of the eye, and the formation of the image and the movements of the eyes, the first group of optical apparatus is devoted to these points. The case contains several forms of artificial eyes, by which the relations and functions of the several parts of the eye may be conveniently reproduced; special devices for illustrating the changes accompanying the accommodation, the path of the rays, the formation of the image upon the retina, the movements of the eyeballs; also apparatus for determining the chief forms of optical defects.

The methods of testing the form sense of the eye, i. e., the accuracy and range of vision under different conditions, are represented by perimeters, optometers, test dots, test letters, test forms, test diagrams, etc. Devices for demonstrating the blind spot, and a variety of accessory apparatus (shutters, diaphragms, dark tubes) are also included in this section.

Color sense.—The first of the two cases devoted to the color sense contains a variety of color wheels, illustrations of color mixture, and methods of detecting color-blindness. The color-wheel is at once the simplest and most universal method of obtaining variations in color and shade. The various types differ mainly in respect to the manner of rotation, whether by hand, foot, clockwork, or electric motor, while special wheels have been devised to permit the proportions of colors to be changed while the wheel is in motion. All these types are represented. In a frame upon the wall are displayed the methods of preparing disks for experiments in color vision. These include slit disks sliding upon one another and thus producing any desired proportion of the component colors; graded mixture, mixture by half-disks, and thus showing the resulting color and the components at the same time; distinction between the pigment and color mixture; methods of measuring color proportions, etc.

The various methods of detecting color-blindness are displayed in this and the following case. For convenience these methods may be classified as the matching,

the naming, the confusion, and the quantitative methods. The matching method consists in placing before the subject a series of pattern or typical colors and requiring him to select out all colors like them. The matching methods are represented by Holmgren's worsteds in various forms, by Gaeton's test wools, a series of wools arranged by Dr. Oliver, the Magnus Jeffries color card, etc. For practical purposes the distinction of color as signals, and of naming them correctly, is important, and has led to a variety of devices for detecting the readiness with which given colors can be recognized and named. Several such devices are exhibited. The confusion method is represented by arrangement of colored bands, with narrow strips of a different color inserted upon them; by colored letters printed on colored backgrounds; by Stilling's test plates, consisting of figures formed by irregular blotches of color upon a background of another color, and by other variations of these. In all these a person with a certain form of color defect is unable to read or distinguish what is clear to the normal eye. In the quantitative tests the object is to determine the precise amount of white and colored light that give rise to the two colors that are wrongly pronounced the same. The chief forms of such apparatus exhibited are those designed by Professor Holmgren, Professor Donders, and Professor Hering.

Several of the pieces of apparatus already described are contained in the second optical case. In addition, this case contains apparatus for illustrating changes of light and shade, contrast of light and shade, collections of disks for various purposes, chromotropes, and also apparatus used in testing the accuracy with which lines and angles and their positions in space may be estimated.

Binocular vision.—The combination of the images in the two eyes to form one picture is a most important fact in vision. The apparatus whose special purpose is to illustrate the process of seeing or inferring the solidity of objects from the two retinal images is the stereoscope. As illustrations of the phenomena of binocular vision are shown rods and other apparatus for demonstrating double images, devices for illustrating the horopter, diagrams for combining points of vision, and a variety of general and special stereoscopes. Methods for obtaining binocular color mixture are also shown.

The lower portion of this case is devoted to the phenomena of color contrast and subjective color. The chief point illustrated is that a background of one color will change a neutral gray into its complementary, green inducing pink, yellow blue, etc. A gray ring placed upon green paper and covered with white tissue paper seems pink; a gray ring formed by the rotation of black and white upon a green sector becomes pink; a black dot seen in reflection upon a white ground in proximity to a black dot viewed through red glass becomes greenish; of the two shadows of a rod, one formed by colored the other by white light, the one shadow will show the color of the light, the other the complementary color, etc. All these forms of color contrasts are shown. The change of color when presented upon different backgrounds and other related points are also illustrated.

Visual inferences: Optical illusions.—The lower portions of the two cases at the north end of the east wall contain illustrations of inferences from visual sensations in distinction to the primitive sensations themselves, and of a few types of optical illusions. Stereoscopic cards illustrate the inferences of solidity or the third dimension of space; several forms of the zoetrope illustrate the inference of movement from an interrupted series of changes of position; diagrams illustrating the interpretation of lines, as the pictures of objects and other similar principles, are also shown. The chief types of illusions illustrated are illusions of relative length and area due to contrast of particular outlines and angles; illusions of change of direction of straight lines, and deviation from parallelism of parallel lines as the result of intersecting angles, illusions depending upon irradiation, etc.

The selection of apparatus bearing upon the form and color sense has been made with the assistance of Dr. C. A. Oliver, of Philadelphia. Dr. B. Joy Jeffries, of Bos-

ton, has contributed largely to the collection of apparatus for the detection of color-blindness.

Hearing.—The apparatus for the study of the sensation of sound, and particularly of musical perception, are so elaborate as to preclude their exhibitions, hence here only the simplest types of apparatus are presented. These include bars for determining the upper limit of audibility, whistles for the same purpose, tuning forks for studying the relations of musical pitch and the sensitiveness to musical intervals, monochord for studying simple phenomena of pitch, resonators for the analysis of overtone, whistles for the study of unison, Galton's apparatus for determining slight differences of pitch, and also a few devices for studying the sensitiveness to slight differences of sound intensity, the power of sound location, and the nature and accuracy of the sense of time intervals.

Movement.—This group of apparatus illustrates the function of movement as an index of mental and nervous conditions. There is an ergograph, or apparatus for recording muscular contractions and thus studying the control over muscles, fatigue, coordination, etc.; an apparatus for demonstrating the changes in the volume of the arm, accompanying volition and mental effort; a sphygnograph for recording the pulse; several devices for recording the involuntary movements of the arm and body; dynamometers for testing the strength of muscular contractions; apparatus for determining the rapidity and regularity of movements; a device for demonstrating tremor; arm holders, and other allied pieces of apparatus.

Recording apparatus.—The value of the experimental study of mental phenomena depends so frequently upon the means of recording the results that one case is devoted to types of recording apparatus. The most universal of these is a kymograph, or revolving drum. The drum is driven by clockwork at a very uniform rate and is covered with glazed paper, upon which a coat of soot has been collected by holding it above a burning lamp. Upon this rotating drum a series of writing points, controlled by electricity or air, write their record by tracing delicate white lines as they expose the paper by rubbing off the light coating of black soot. These records are then bathed in shellac and made permanent. In the study of movement, in the recording of time intervals, in the analysis of the relations between physiological and psychological processes, in the study of the proficiency of voluntary control, in the study of the interference of sensory and motor processes as a means of electric contacts, and in a variety of other ways, such an apparatus is indispensable. Several such kymographs, both simple and complex, with a variety of attachments for insuring change of rate, convenience in manipulation, adaptation to different forms of experiment, etc., are represented either by the apparatus itself or by photographs. Electrical attachments are represented by time markers, tuning forks, phon-autographs, Deprez signals, electric keys, switches, magnets, etc.; pneumatic attachments by simple and complex tambours of various types; apparatus for recording the movements of the lips, of the voice, of the throat, of the pulse, of the respiration, of the contraction of muscle, of the fingers, and the like.

Time-measuring apparatus.—The study of the time consumed by simple mental processes forms one of the main divisions of experimental psychology. The applications of such study and the generalizations to which it leads are of importance and value in many directions. Time-measuring apparatus is also needed in other types of psychological research.

For measuring long intervals a stop watch and a metronome are shown, the stop watch measuring to the nearest fifth of a second, the metronome to the nearest one-fourth of a second. More convenient is an automatic metronome which can be started and stopped by the closing of an electric circuit and which registers the number of oscillations. The metronome may be made to register its oscillations upon a rotating drum. Two forms of interrupting clocks for this purpose are also exhibited. By means of these clocks a great range of intervals may be accurately recorded.

Tuning forks registering one one-hundredth or one two-hundred-and-fiftieth of a second are exhibited. The chronoscope of D'Arsonval enables the observer to read off on a dial one one-hundredth of a second, and has the advantage of being noiseless. A mechanical clock designed by Professor Münsterberg also registers to one one-hundredth of a second; a water chronoscope, the time being measured by the amount of fall of a column of water, registers to one two-hundredth of a second or less, while the Hipp chronoscope (two mountings of which are shown) registers to the nearest one one-thousandth of a second. There are also exhibited certain special reaction time instruments that record by the vibration of a fork the interval elapsing between the presentation of a stimulus and a response to it. Those represented are designed by Beetz, Donders, Exner, Bowditch, and Fitz.

Accessories for reactions.—To complete the outfit for the study of reaction times there are needed means for controlling the time-measuring apparatus, various forms of stimuli for impressing the various senses and presenting mental problems, and various simple and complex forms of reaction keys. In addition a shutter or other means of determining how much can be recognized within a brief interval of exposure is needed. Types of all these forms of apparatus are represented. For control the falling of a ball or of a shutter or the swing of a pendulum may be used, the theoretical being compared with the actual time. As types of stimuli for sound a sound magnet, which also yields a premonitory signal, and electric bell are displayed; for touch a mechanical key and an induction coil (furnishing an electrical stimulus), and also a special key by which a shock may be given to the finger by which the reaction is made; and for sight several forms of exposure aparatus, by means of which any one of two or more objects may be shown simultaneously with the starting of the chronoscope. Apparatus for a "chain reaction," in which the reaction of one subject gives the stimulus for the next, is also shown. In addition a variety of material used as stimuli and in the study of memory, attention, and association, such as sets of words, letters, numbers, pictures, colors, lines, etc., are displayed and described. Of reaction keys there are forms for simple reaction with the finger; for reaction with any one of the five fingers, a reaction keyboard with fifty keys, a foot key, a lip key, speech keys of several types, etc.

The platforms.—The instruments exhibited upon the platforms are an apparatus for showing the relation between the attention and the moment of receiving a stimulus, a large apparatus for the study of movements of the arm with and without resistance, a color wheel for foot power, a general optical testing board, a large stand for the study of æsthetic proportions, a time-sense apparatus, an apparatus for demonstrating the perception of distance; a square for visual estimates of length and area, a universal chronograph for recording intervals of various durations, and several others.

Photographs, etc.—Both within the cases and without the walls are exhibited photographs of apparatus which serve to supplement the collection.

Certain points of especial interest in view of recent advances, in addition to this detailed account, by Professor Jastrow, may be included within the limits of the popular presentation required by this report.

The collection of apparatus is probably the most complete, as a whole, that has ever been made, notwithstanding some obvious deficiencies. For example, instruments for sound and tone experiments are almost altogether wanting; and if this omission is excusable in the working laboratory, considering the incessant noises made by the busy fair goers, it is unaccountable in a simple apparatus exhibit, except on

the supposition that makers and owners could not be persuaded to contribute. The pieces for sight, muscle sense, and color sense are well chosen, and so is the apparatus for demonstrating the laws of reaction time and other special psychophysical principles. Of course it is impossible, without becoming too technical, to give a detailed account of these instruments, but some remarks on a few of the more recent adaptations of physical research may interest general readers.

The kymograph of Ludwig, exhibited by Petzold, of Leipzig, still holds its place as probably the most complete and available apparatus for graphic recording. The instrument at the fair has, besides a spiral attachment, an excellent device for tilting the revolving drum at any angle to the perpendicular. A new instrument of the same kind, with much to commend it, was shown by Dr. Witmer in the University of Pennsylvania exhibit. Rothe, of Prague, sends a "polygraph" with accessories (after Knoll), which provides a very cheap revolving-drum movement of two velocities with a variety of tambours for recording and a seconds clock for time marking. Among other time measures the two latest chronoscopes are those exhibited by Elbs and Verdin, devised, respectively, by Münsterberg and D'Arsonval. They are both excellently adapted to measurements to hundredths of a second, and both can be made to record thousandths. The D'Arsonval has this advantage over the other, as well as over all previous chronoscopes, viz., that it is practically noiseless. It is also portable, and in its attachments very convenient for the simpler reaction demonstrations. Among the pieces of apparatus for investigating movement, those of Cattell and Münsterberg are adapted to a great number of special uses, the former affording ready measurement of force and rapidity, and the latter of direction, locality, symmetry, etc.

A new improvement in the matter of devices for color mixing is shown in two instruments to be found among the exhibits of the University of Pennsylvania and the German universities, respectively—the former due to the ingenuity of Dr. Witmer and the latter worked out by Professor Ebbinghaus, of Berlin. They both have appliances for regulating, during the revolution of the wheel, the amount of surface of each disk exposed. They both secure this (so far as they do secure it) by means of a spiral interlocking arrangement of concentric tubes supporting the different disks, so that by moving one tube within the other it is also turned upon its axis, thus disclosing or concealing more or less of the color disk which it bears. Other interesting pieces of apparatus are the color-contrast instruments of Hering, exhibited by Rothe, of Prague; a series of contrivances for utilizing the principle of the Marey tambour, exhibited by Verdin, of Paris; the new control hammer of Wundt, for use in connection with the Hipp chronoscope (in the German educational exhibit); Stumpf's tone instruments (also in the German collection); Münsterberg's large "Augenmass"

apparatus for experimental work in the dimensions, locations, etc., of the field of vision; Cattell's dynanometer, and the capital series of simple sense-test appliances exhibited by Jastrow.

In the testing room the series of interesting sense and memory tests were given to all comers. The educative value to those taking them, and to the public generally, is probably their greatest value under the circumstances, which are not conducive to scientific accuracy. More may be expected, however, from the series of results obtained from different colleges in this country, where the same tests were given to groups of students by competent instructors before the fair opened. The arrangements for administering these tests, I may add, exhibit much ingenuity; indeed, two of the pieces of apparatus used—one a time marker constructed on the pendulum principle with well-contrived accessories (from Dr. Fitz, of the Lawrence Scientific School), and the other a new falling screen for brief exposures to the eye, designed by Professor Jastrow—are, in my opinion, improvements on most of the older contrivances for their particular uses.

(B), (C), (D), (E). THE EXHIBITS OF (B) THE GERMAN EDUCATIONAL DEPARTMENT; (C), THE "DEUTSCHE GESELLSCHAFT FÜR MECHANIK UND OPTIK;" (D), INDIVIDUAL PRIVATE INSTRUMENT MAKERS; AND (E), SEPARATE UNIVERSITIES.

The two German agencies mentioned as (B) and (C) send what may be considered as on the whole the best indication—when taken in connection with the special pieces of apparatus sent from German workshops to the collective exhibit of the department of anthropology—of the application of modern mechanical skill to the construction of instruments of the delicacy required for psychological experiment. These instruments are mainly adaptations of well-known principles and often of well-known apparatus used by experimental physiology, physical optics and acoustics, electricity, etc. The instruments shown by the German Mechanical and Optical Society are almost entirely common to psychology and these sciences. The pieces in the German educational exhibit are largely the special arrangements found useful in the laboratory at Leipzig, and so show very inadequately the real progress of the science in Germany. Yet they are of great historical interest. The collection is much less complete than that made by the German instrument makers in connection with the collective exhibit in the department of anthropology. In this connection it should be mentioned that the account given of experimental psychology in Germany, by Professor Wundt, in the official book, "Die Deutsche Universitaten," prepared by the imperial minister of education, is not adequate (and probably the author did not intend it to be considered so) when taken as an exponent of the present condition of this science and the place it occupies in the German universities.

(D) The private exhibits of individual firms should be noted in the attempt to make one's conception of psychological activity complete. French exhibitors did not combine as the Germans did, and so lost both in effect and in local position. Yet much of the finest work is done in Paris, as is witnessed by the cases of surgical, physical, and psychological instruments grouped in the north end of the anthropology building. An examination of the catalogue of Ch. Verdin and Rudolph König, both of Paris, may serve for the details of this class of exhibits, as the united catalogues of the other collections mentioned serve in respect to them. The German makers have done their work more largely in connection with great university laboratories, and so have subserved better the needs of particular students in solving particular problems in physics and psychology; the French, on the other hand, have found the demand more marked from the side of clinical medicine and experimental physiology.

(E) The separate university exhibits of the universities of Pennsylvania and Illinois were located, respectively, in the Liberal Arts and Illinois State buildings. The aim of the former was to present a working laboratory restricted to a small number of topics. This original purpose was not subserved through the failure to provide competent attendants to collect experimental data; yet the arrangements for experiments in reaction times and the visual æsthetics of form were instructive to visitors. Two pieces of new apparatus were exhibited, both of which have already been referred to in what precedes—a color wheel and a revolving-drum movement for graphic recording.

The exhibit of the University of Illinois was mainly of instruments, which were also included in the main collection of the department of anthropology. It was in charge of Prof. W. O. Krohn of that university.

IV. Educational.

The educational aspects of the new work in psychology are of great importance. It is evident that education has two claims to make upon this study. One of these claims the old psychology aimed to meet; the other it was incapable of meeting. The first of these two duties of psychology to education is this: It should take its place as a factor in liberal collegiate culture in both of the functions which a great branch of learning serves in the university curriculum, i. e., undergraduate discipline and instruction and post-graduate research discipline.

The older psychology, especially in America where it was hampered by the conditions pointed out in an earlier section, did, as I say, aim to instruct undergraduates. But even in this it was a means to another end; it was propædeutic to a philosophy and to a theology both of which, as far as their demands upon "mental science" were concerned, were dogmatic and intolerant. But the graduate disciplinary function

was never served in any sense by the faculty psychology nor by the philosophy founded upon it in America.

The second great educative function of psychology is this: It should mold and inform educational theory by affording a view of mind and body in their united growth and mutual dependence. Education is a process of the development under most favorable conditions of full personality, and psychology is the science which aims to determine the nature of such personality in its varied stages of growth, and the conditions under which its full development may be most healthfully and sturdily nourished. One of the first duties of psychology, therefore, is to criticise systems of education; to point out "the better way" in education everywhere, and to take no rest until the better way is everywhere adopted. This duty the old psychology did not realize; indeed, by its methods and results it was cut off from the realization of it. It shall now be my aim to show how contemporary psychology is addressing herself to all these undertakings.

A. PSYCHOLOGY AS RESEARCH DISCIPLINE.

I begin with this point because it is the most striking fact about the present state of psychology in all countries where the experimental idea has been given entertainment. Probably students and general readers hear more about "research" in connection with psychology than with any other branch. And it is odd—indeed, to workers in other departments, amusing—that all this claim to research ability and talk about "original contributions to knowledge" is by professors who are yet smooth faced and generally quite inexperienced in university affairs. A physicist who makes contributions to knowledge is extremely rare, but the "new psychology" has two men of research to every competent college instructor in its ranks.

This, I take it, is a hopeful and encouraging state of things, and has its origin in two influences. First, the new impulse has come from Germany, where the university function corresponds very nearly to the graduate-discipline function in the few American institutions where graduate work is encouraged; and, second, because the actual state of the subject is such that research is a matter of comparatively less difficulty than in the older scientific branches. Yet the actual value of this condition of things in the permanent development of the subject must be held to be disciplinary and educational, for the more serious and philosophical of the psychologists do not expect these first results of the new methods to be revolutionary in their value, nor have the researches so far published been much more than suggestions of what may be done when the method is held under better control and those who apply it have had adequate discipline and training in its use.

Accordingly, in my view, the very marked tendency to "research" evident in the management of the new laboratory foundations of the

colleges in this country is of main value as offering training to the future instructors in psychology throughout the land rather than as offering contributions to knowledge. The students in these laboratories come largely from colleges where experimental psychology is unprovided for or held up for criticism by professors of philosophy. The utilization of their results, except in problems whose solution properly involves ignorance, crudity, and liability to individual variation is manifestly impossible.

The research discipline offered by graduate work is indispensible, however, as discipline since it is at present the only substitute for undergraduate discipline. This, indeed, is the function of graduate work in the other departments of science in the universities. It is emphasized, however, in psychology since, as I shall show below, undergraduate instruction in experimental psychology is still in an inchoate condition, even in the few larger institutions in which it has been added to the B. A. course of study.

Chairs in experimental psychology, occupied by men whose principle function is graduate discipline—although, in some institutions, the undergraduate function is being recognized—are now no longer novelties. Abroad, the German universities take the lead in such instruction, yet the instructors are generally professors of philosophy or of psychology, who offer experimental courses. Laboratory foundations began in Germany, in 1879, with the institute at Leipzig (Professor Wundt); they are now to be found as well at Berlin (Professor Ebbinghaus), Göttingen (Professor Müller), Bonn (Professor Martius), Prague (Professor Hering), Munich (Professor Stumpf), Heidelberg (Professor Kräpelin). As for other European countries, a chair of experimental psychology was founded in the College de France in 1886 (Professor Ribot), and a "Laboratoire de psychologie physiologique" opened at Paris, in the Sorbonne, in connection with the École des Hautes Études in 1891 (Professors Beaunis and Binet).

Other such continental foundations are to be found at Geneva (Professor Flournoy) and at Rome (Professor Sergi). In Great Britain and her possessions, the analytic method has not given way to the experimental. In Canada alone, at the University of Toronto (Professor Baldwin), a well-equipped laboratory was opened in 1891, although a little later a small sum was secured for the purpose of beginning work of this kind at the University of Cambridge, England. Lectures are given, however, both by physiologists (Professor Hill at University College, London, 1894) and by professed psychologists (Professor Alexander, Owens College, Manchester, 1893). Japan follows with one such laboratory, that at the University of Tokyo (Professor Motora).

In the United States the extension of this method of treatment has been rapid and the establishment of chairs and of laboratories extraordinary. The first laboratory was established in 1883, at Johns Hopkins

University (Professor Hall), but it was closed in 1887. This was followed in 1888 by the establishment at the University of Pennsylvania of the first chair of psychology alone with a laboratory (Professor Cattell). Here the first undergraduate laboratory instruction was given. Later, chairs for experimental psychology alone have been erected at Columbia College (Professor Cattell); Harvard University (Professor Münsterberg), where an additional professorship in general psychology exists side by side with it (Professor James); the College of New Jersey at Princeton (Professor Baldwin). Professorships, either in psychology as a whole or as associated with education, exist at Clark University (Professors Hall and Sanford); Wisconsin University (Professor Jastrow); Cornell (Professor Titchener); Chicago (Professor Strong); Indiana (Professor Bryan); Illinois (Professor Krohn); Stanford (Professor Angell); Catholic University at Washington (Professor Pace); Wellesley College (Miss Professor Calkins). Of all these institutions laboratories with equipment have been provided, and such provision has been made in others where no separate professorships have yet been erected—i. e., Yale (Professor Ladd); Brown (Professor Delabarre); Minnesota (Professor Hough); Nebraska (Professor Wolfe); Michigan (Professor Dewey).

The nature of these laboratories is illustrated by the large exhibit already spoken of. That at Harvard University is the largest, best equipped, and most freely patronized by graduate students. A Harvard pamphlet catalogue of the apparatus in the laboratory, containing also illustrations, bibliographies, and a list of topics under investigation (twenty-three in number) was prepared by Professor Münsterberg for the collective university exhibit. The rooms given to this science, however, in the universities are usually inadequate and ill adapted. The only such laboratory yet planned and constructed especially with regard to the requirements of this work is that at the University of Toronto, of which a description, with plan, is to be found in "Science," XIX, 1892, page 143. The most extensive accommodation yet provided for this work is probably that at Yale College, where a house with 15 rooms is devoted to it. A description of the main features of the Yale laboratory is also to be seen in "Science," XIX, 1892, page 324.

The following selected topics set recently for original investigation in four of the institutions may be taken as typical of the kind of themes through which the graduate discipline acquired in all these foundations is secured:

Columbia, 1883–84.

"The perception of dermal stimuli."

"After-images—their duration and nature as a function of the time, intensity, and area of stimulation."

"The time of perception as a measure of differences in intensity, and the correlations of time, intensity, and area."

"The perception and attention of school children."

"The sensation resulting from the combination of colors."

Harvard.

"The influence of the content on the judgment of the length of a time interval, filled and limited by visual impressions."

"Studies on memory, especially the relation of disparate senses in recollection, the comparative value of different contents, and the results of simultaneous and successive presentations."

"A study of the comparative influence of vividness, repetition, and recency on the process of association."

"The time relations of the association of isolated presentations as compared with the association of presentations combined into sentences."

"The conditions under which dissociation of simultaneous perceptions may occur."

"A study of elementary æsthetic forms and proportions with respect to the influence of content and position, more especially with reference to our sense of symmetry and compensation in the relation between intensity and interval."

"The æsthetic value of combinations of colors, and its dependence upon their positions and relative sizes."

"The influence of previous motor ideas in producing unconscious movements during the execution of a later voluntary movement of a different kind."

Yale.

"Reaction time and attention."

"The time required for altering the accommodation of the eye."

"Reaction time in relation to intensity and pitch."

"The musical sensitiveness of school children."

Princeton.

"The progressive fading of memory for size of visual figures."

"Investigation of memory types by means of reaction times."

"Size and color contrast effects on the retina."

"Complex illusions of rotation."

"Investigation of 'temporal signs' by means of mistakes in order and omissions in the memory of sound and color series."

"Experiments on 'will stimulus' by observing the motive influence of memories of less and less intensity and clearness."

The treatment of general psychology is adequate as never before also, in the graduate instruction of the country. The courses of lectures and the instruction by the Seminar method gather large numbers of students who have already graduated in less pretentious colleges. The publication in recent years of so many systematic treastises, especially in America, has contributed to this; a dominating influence in this matter being a work, which has proved to be a vade mecum to psychological inquirers, the "Principles of Psychology" of Prof. William James.

B. PSYCHOLOGY AS UNDERGRADUATE DISCIPLINE.

The position of psychology in the undergraduate curricula of the leading institutions also invites remark. Two important changes may be discerned in recent years, both indicating the permanent breaking away of this discipline from its connection with theological system;

First, the recognition of the aim of the science as self-knowledge and self-control, and, second, the introduction of the experimental method of instruction.

The first of these tendencies is shown in the remarkable change worked (and still working) in the qualifications and training of the occupants of chairs in philosophy and psychology. Even the smaller denominational institutions are following the lead of the great Eastern foundations and of the progressive State universities in seeking men who are trained to the same rigorous interpretation of fact and search for it that are the first requisites of the genuine Naturforscher in other branches of science. The guardianship of this important realm—the mind—from outside, in the supposed interests of religious and ethical truth, has had its day in many institutions, at least in any sense that denies to the investigator and teacher the full liberty of disputing what facts do not support, and of stating hypotheses, however novel, which well-observed facts do support. Consequently, philosophy and psychology are now self-controlling departments in the colleges; and so the courses of psychology are arranged with view both to the adequate instruction of the student in its history and results, and with view to that high discipline which the pursuit of the "moral" as opposed to "physical" and "natural" sciences undoubtedly gives.

Second, the introduction of the experimental method of instruction has had its beginning. It consists in the actual demonstration of the leading facts of experimental and physiological psychology in the class room, with added opportunities for students to perform them upon one another and, under certain topics, upon the dissected nervous systems of animals. One of the results is the greater concreteness and interest given to the subject for younger students and the correspondingly increased election of all the branches of the tree of philosophy in the later years. The union of the two functions of introspection and experimental observation thus secured renders this branch, in my opinion, of unique and as yet undeveloped value in the total discipline of college life.

It is evident that this undergraduate service can not be adequately realized until the science which aims to render it is itself well developed and sufficiently categorized. The actual condition of things suggests encouragement, therefore, but not enthusiasm. It is evident that such a method of instruction is at present impossible to any but the original workers in this field, and they, indeed, are each a law unto himself. There are very few experiments of a psycho-physical or psychological kind which are of such evident importance and value as to be recognized by all as available for class demonstration. And a more radical defect is that there are very few principles as yet formulated which can be adequately demonstrated by single or grouped experiments. Add to this the fact that the whole exhibit of apparatus

at Chicago contained very few things which are suitable and convenient for untrained use or illustration, and the difficulties become in part apparent. It is a duty which experimental psychology owes to education to meet this need by bringing her results into line with the more elementary principles of general psychology, of providing simple apparatus which can be used by less expert instructors, and of preparing text-books for junior classes. While no text-book to-day exists for this purpose, it is yet gratifying that two such "courses in experimental psychology" have already been announced by competent writers, both Americans (Professor Cattell, of Columbia College, and Professor Sanford, of Clark University).

Reference to the latest catalogues of Brown, Wisconsin, and Michigan universities (not to mention many others) may serve to show the nature of the courses offered in institutions where the work is as yet mainly undergraduate.

C. PSYCHOLOGY IN ITS BEARINGS ON PEDAGOGY.

Finally, the relation of psychology to the science of education may be given a word after the discussion of its place in practical education. Pedagogy as a science treats of the application of psychological principles to the development of normal and cultured personality. The ground work of such a science must be afforded, therefore, by psychology; and inasmuch as the teacher has to do with body as well as mind, and with mind principally through the body, it is experimental or psychophysical psychology to which this duty to theoretical education mainly comes home. It is needless to say that there is no such science of pedagogy in existence. Most of the books which have heretofore appeared in America on this topic—and their name is legion—are unworthy of serious attention. Further, the importation of the German a priori systems of pedagogics finds its main service in keeping awake the expectation and the amour penser of teachers, not in affording them much empirical assistance in their task. Yet it is encouraging that the phrases "child study," "self-activity," "apperception," "scientific methodology" are in the air in this year of the Exposition, and every teachers' convention listens to hours of paper on such topics.

Contemporary psychology is becoming aware of this duty also, however far she may yet be from performing it. Children are being studied with some soberness and exactness of method. Statistical investigations of the growth of school children, of the causes and remedies of fatigue in school periods, of the natural methods of writing, reading, and memorizing are being carried out. The results of several such inquiries were plotted for exhibit in the department of anthropology at Chicago. Questions of school hygiene are now for the first time intelligently discussed. The relative values of different study

disciplines are being weighed in view of the needs of pupils of varying temperaments and preferences. And it only remains for the psychologists—themselves teachers—to set the problems and establish the methods, and all the enthusiasm that is now undirected or misdirected will be turned to helpful account. Among those who have addressed themselves to this task in this country with information and influence two names may be mentioned, that of the Hon. W. T. Harris, United States Commissioner of Education, editor of the International Education Series, which now includes twenty-four volumes, and President G. Stanley Hall, of Clark University, editor of the Pedagogical Seminary (Vols. I–III, 1891–1894). Another journal which is doing good work for sound education is the Educational Review, edited by Prof. N. W. Butler, of Columbia College (Vols. I–VII, 1891–1894).

V. Psychology and Other Disciplines.

It is necessary, in order that this report may adequately present the conditions under which psychology exhibits herself and her historical progress, to speak briefly, also, of the relations which this topic sustains to the other "moral" forces which make up largely the culture element in our present-day social environment. The traditional connection with philosophy is not severed by the new directions of our effort; but, on the contrary, they are made more close and reasonable. The change in psychological method was due in part, as I have said above, to changes in philosophical conception, and it is only part of the same fact that scientific psychology is reacting upon philosophy in the way of healthful stimulus. Both the critical idealistic and the critical realistic methods of philosophy are richer and more profound by reason of the lessons of the new psychology. It was only just that the science which owed one of its earliest impulses in this country to a book from an advanced thinker of the former school, the Psychology of Prof. John Dewey, of the University of Michigan, should repay the debt by its reconstruction of the Kantian doctrine of apperception in terms acceptable to the later thinkers of that school. And it is no small gain to both schools that their issue should be joined, as it is to-day, on ground which stretches beyond their old battlefields by all the reach of territory covered by the modern doctrines of Naturalistic Evolution and the Association Psychology. Philosophy escapes the charge of Lewes, that her discussions are logomachy when the disputants on both sides are able to look back upon those even of the late period of Lewes and admit the essential truth of both of their hotly contested formulas. As far as this is the case, I venture to say that it is due to the progress of psychology in giving content to the terms of the logomachy and in enabling the best men to reach more synthetic and more profound intuitions.

The relation of psychology to theology also is now as close as ever, and must remain so. And the obligation must become one of greater mutual advantage as psychology grows to adult stature and attains her social self-consciousness in the organization of knowledge. The benefits which theology might have gained from psychology have been denied through the unfortunate attempt to impose the theological method upon the treatment of the whole range of mental fact. The treatment of "Anthropology" included in the text-books of systematic theology bears about the same relation to that of current psychologies, like Hoffding's and James's, as the physiology of the philosophers not long since bore to the work of the neurologists and morphologists. It is evident, however, that this condition of things is now happily mending, and it is to the credit of one man, ex-President James McCosh, of Princeton College, that he first of the theologians who were teaching philosophy in this country welcomed and advocated the two new influences which I have taken occasion above to signalize as the causes of the better state of things—the influence of the German work in psychology (preface to Ribot's German Psychology of To-day, 1876) and that of the evolution theory in biology (Religious Aspect of Evolution).

Finally, I may note the growth of a new department of psychological study which aims to investigate the mental and moral life of man in its social and collective conditions. The evident need of such subjects as sociology and criminology is the knowledge of the laws of human feeling and action when man is found in crowds, orderly or disorderly, and in organizations legitimate or criminal. This need is now beginning to be felt both by sociologists and by psychologists, and we may hope that the questions already started in Italy (Ferri Sighele, "La foule criminelle," 1893), France (Tarde, "Les Lois de l'Imitation," Guyau, "Education and Heredity," Eng. trans., 1892) and England (Spencer, "Sociology") may receive fruitful development in this country. It is an interesting sign of the times in education that the theological schools are beginning to realize the need of such knowledge of collective man as part of the training of the ministry. Instruction in social questions is made a separate department in the Yale Divinity School and in the Chicago Theological Seminary, as well as in other such institutions.

En résumé: I have only to add that psychology is now the branch of knowledge which is developing in most varied and legitimate ways, and that the exhibition made at the Columbian Exposition, while not adequate in many respects, yet served, to those who studied it intelligently, to indicate the present gains and the future prospects of the science.

EUROPE AND THE FAIR.

BY

THEODORE STANTON.

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It is the purpose of this chapter to describe, not the exhibits sent to Chicago by the various nations of Europe, but to tell what was done to bring these exhibits together. Wherever it has been possible I have let speak for themselves the various persons who aided in this important work, thinking thus to give more authority to my history. I am indebted, furthermore, to Hon. James S. Ewing, United States minister to Belgium; Hon. James O. Broodhead, United States minister to Switzerland; Hon. Eben Alexander, United States minister to Greece; Hon. George W. Caruth, United States minister to Portugal; Mr. J. W. Riddle, United States chargé d'affaires at Constantinople; Mr. Stephen Bonsal, secretary of the United States legation at Madrid; Mr. Lawrence Townsend, secretary of the United States legation at Vienna, and Mr. Thomas B. O'Neil, United States consul at Stockholm.

AUSTRIA.

The secretary of the Vienna chamber of commerce writes me as follows:

The invitation of the United States in regard to the participation of the Austrian Government in the Chicago Exposition, was received by the Imperial Royal Court, the cabinet, and the parliament in a very friendly and courteous way. The Austrian parliament having granted 275,000 florins for Exposition purposes, the minister of commerce immediately notified all the chambers of commerce and the other interested industrial corporations concerning the Government's intention, to be officially represented at the Fair and requested them to call the attention of the manufacturers and merchants of their respective districts to the fact.

The great interest shown by all interested people in the various parts of Austria, (Hungary had declined to take part) determined the Government to organize a commission. This was done on February 21, 1892. The commission was under the auspices of the Marquis de Bacquehem, minister of commerce, and was called the imperial royal central commission for the Chicago Exposition of 1893. The Archduke Charles Louis kindly accepted the honorary presidency, while the minister of commerce was active president. The commission consisted of ninety-five members, divided among several special subcommittees, of which the most important was the executive committee, with Hon. R. Isbary, president of the Vienna chamber of commerce, as chairman, whose place was taken after his death by his successor, the actual president of the chamber of commerce, Max Mauthner. This board had to perform the whole work of organization and was in close communication with the Exposition authorities at Chicago.

Hon. A. von Palitschek-Palmforst, Austrian consul-general in New York, was appointed commissioner-general to the Exposition.

The number of our exhibitors was nearly 800. From the Government appropriation of 275,000 florins there was spent for Exposition purposes, such as installation, decoration, insurance, salaries, etc., 235,000 florins.

Several specialists were sent by our Government to the Chicago exhibition, and Austria was represented by 22 judges on the international jury. The number of awards obtained by Austrian exhibitors amounted to 460, nearly 60 per cent. The value of the goods sent may be estimated at $1,400,000. Goods were sold to an amount surpassing $600,000.

The woman's committee was under the patronage of the Archduchess Maria Theresia, and included Countess Havrach, Countess Larisch, Princess Henriette Lichenstein, Countess Thun and Hohenstein, and other members of the nobility.

Col. Frederick D. Grant, formerly United States minister to Austria, writes:

The invitation from our Government to Austria-Hungary to participate in the Exposition at Chicago was not responded to promptly by Austria, and was not accepted at all by Hungary. The interest which the Austrian Government and people finally took in the Exposition had to be worked up and aroused by the United States representatives and officials who were at that time in Vienna. I am proud to say that through the efforts of myself and those assisting me the Austrian exhibits at Chicago were most creditable and interesting.

BELGIUM.

Senator Vercruysse-Bracq, president of the board of commissioners appointed by the Belgian Government for the Chicago Exposition, sends me the following information:

As soon as the Belgian Government received the official invitation to participate in the Chicago Exposition, the superior council of commerce and industry was called together in order to obtain its views on the subject. The council was uniformly of the opinion that as far as possible a participation ought to be organized, and a committee was appointed to encourage, bring together, and enlighten would-be exhibitors. The Government asked the Senate and Chamber of Representatives for an appropriation, which was granted, and which amounted to 300,000 francs for industry, 40,000 francs for fine arts, and 10,000 francs for the woman's exhibit. The King took a lively interest in the Belgian exhibit, and the Queen consented to act as patroness of the woman's committee. A subcommittee on the fine arts was formed under the presidency of M. Hingenaeger, who has since died. The horticultural side of our work was also important. More than 200 of the chief manufacturers of the country exhibited at Chicago, some of whom attended the exhibition personally, accompanied by the president of the committee, the commissioner-general, M. Jimmis. More than 200 artists also exhibited with remarkable success. Notwithstanding the differences occasioned by the system of awards, our exhibitors were pleased because the Fair opened up to them new markets for their goods, and those of us who visited Chicago will retain a lasting impression of it.

DENMARK.

Hon. Clark E. Carr, formerly United States minister to Denmark, says:

When I, in the name of our Government, extended the official invitation, the Government and people of Denmark manifested great interest in the Exposition, though it seemed doubtful whether the former would take any action in regard to represen-

tation. It appeared to them too great an undertaking to prepare themselves for an exhibition at a locality so far away as Chicago.

There is a great organization in Denmark, known as the Industri-Forretning, or industrial association, whose headquarters are at Copenhagen. This association combines for their general good most of the industries of the Kingdom. I soon learned that the attitude of Denmark in regard to the Exposition would in a great degree depend upon the action of this association, and that in fact his excellency, Mr. Ingerslev, the minister of the interior, had referred the matter to this association. I at once approached Mr. Carl Michelsen, the president of the association, and other members, and presented to them such considerations as occurred to me, showing the importance of Denmark, and especially to her industries, of being represented. Soon after, I received information that on a certain day commissioners from Chicago, in the interest of the Exposition, would arrive at Copenhagen, and through President Michelsen, arranged for representative members of the industrial association to meet the commissioners upon their arrival. These commissioners came, headed by Mr. F. W. Peck, of Chicago, and they spent most of a day in laying the matter before the gentlemen who represented the industrial societies. The result was the earnest and active enlistment of all the industrial associations of the Kingdom in favor of Denmark's proper participation. So soon as the industrial societies manifested this disposition the minister of the interior took up the matter and zealously favored official action. In the meantime the matter was generally discussed among the people. The newspapers also took it up. I, of course, through correspondence with the Department of State at Washington, and with the officials of the Exposition at Chicago, did what I could to disseminate information in regard to the Exposition, and to show the importance to the Kingdom of taking part in the enterprise.

When the matter finally came up in the Rigsdag there was no division in sentiment as to whether Denmark should be represented, the only question being as to the amount of the appropriation. The amount appropriated was 250,000 kroners, about $65,000, to which another considerable sum was added later, amounting in all to about $75,000. It is claimed that in proportion to population and wealth the amounted expended by the Danes was greater than that of any other people of the world.

I need not speak in detail of the splendid exhibit made by Denmark at Chicago. This showed for itself. But I deem it proper to say a word concerning the beautiful exhibit made by the ladies of Denmark, who were influenced in a great degree to act in the matter by Madame Kammerherinde Sophe Oxholm, at the solicitation, through me, of Mrs. Palmer, president of the board of lady managers. Many ladies of the highest rank and position in the Kingdom sent from their homes their rarest treasures for a loan exhibition. The Queen contributed a beautiful picture painted by her own hands, the Crown Princess embroideries and laces which she herself had made, and the Princess Marie several pictures which she had painted.

Altogether the Danish exhibit was such as to reflect the greatest credit upon a people which in intelligence and in all that is noble and worthy is scarcely equaled and not surpassed by any other nation of Europe.

FRANCE.

The invitation was presented to France through the Hon. Whitelaw Reid, and was promptly accepted by the French Government, M. Ribot, the minister of foreign affairs, in announcing the fact to Mr. Reid, remarking:

I think France is the first European nation to accept the invitation, and, anyway, I hope so.

And such was the case. In April, 1892, Parliament voted a credit of 3,250,000 francs, to which 800,000 more francs were added in July following, making a grand total of over 4,000,000 francs. In May of the same year M. Camille Krautz, deputy for the Voges, who had already held official connection with two of the Paris Exhibitions, was appointed commissioner-general, and immediately organized a large and active bureau. A week later the minister of commerce announced the formation of thirty-nine committees for the various kinds of exhibits, composed of the most distinguished specialists of France. The officers of these committees formed a commission of revision, whose president was the minister of commerce. Finally, on July 8, 1892, the minister of commerce constituted a woman's committee, presided over by Mme. Carnot and composed of thirty women well known in philanthropy, art, and letters. M. Jules Siegfrid, deputy for Havre, who a few months later became minister of commerce, and who was from the start an ardent champion of the Exhibition, was the prime mover in the organization of the woman's committee, which met several times in the Elysée Palace under the presidency of Mme. Carnot, the first time that women were given, in France, this high official recognition.

M. Yves Guyot, ex-deputy and ex-minister of public works; M. Georges Berger, director-general of the exhibition of 1889, and Mr. Henry Vignard, secretary of the United States embassy, were especially active in awakening interest in France. The author of this chapter, assisted by Mr. I. A. Bowen, special Treasury agent, opened a bureau of information and helped in various ways to spread knowledge concerning the Fair.

GERMANY.

Mr. Ad. Wermuth, the active German commissioner-general to Chicago, writes me:

As far as Germany was concerned, the early reserve and opposition against participation was soon overcome and in many instances ceded to sympathy and even enthusiasm. Immediately after my return from Chicago, in the autumn of 1891, the organization began. On account of the wide extent of the German Empire and of the great variety of our industries, the first task was to convince the leading centers that their own interest demanded Germany's participation in the Exhibition. This view began to gradually gain ground even in circles which had at first shown unfriendly feeling for the American enterprise, basing their lukewarmness—with good cause, it must be admitted—on the ground that they could not hope to derive any direct benefit from their participation. In some cases sentiments of patriotism influenced many to assume the heavy expenses always associated with the sending of exhibits to international fairs. Others were induced to come forward though the probability that the presence at Chicago of a large number of visitors from Mexico and Central and South America, from the Antilles, from China, Japan, and Australia, would open up new fields to German trade.

For the first time in the history of international exhibits, that of Chicago had to overcome the difficulty of the seat of the Fair being nearly 1,000 miles inland.

From the fact that the Chicago Exhibition buildings were constructed on a gigantic scale, it was necessary to present exhibits in collective groups in order that they might make an impressive showing in proportion with the august surroundings. A large number of our industries having been brought over to this view of the matter, Germany was especially represented at Chicago by many such collective exhibits.

Among the last letters written by the late Hon. William Walter Phelps was one from Fortress Monroe containing this statement:

In German Fair matters nothing came especially to my notice, except the Krupp exhibition. He is a schoolmate of my son-in-law, through whom I made Krupp's acquaintance, and teased pretty sedulously, Krupp would say: "But what good for me in it? You will never buy guns from me; and at the least it will cost me $250,000." It subsequently cost him more. My only answer was: "Glory personal! The glory of your country! Possibly the trade of Japan, China, and South America." I don't know whether he would have succeeded, but Wilhelm, very chummy with Krupp, almost insisted. That settled it. At every point Wilhelm helped the Exhibition.

GREAT BRITAIN.

Sir Henry Trueman Wood, commissioner-general for England, thus describes the work done in that country:

In March, 1891, Mr. Robert T. Lincoln, who was then American minister to Great Britain, reported to the Marquis of Salisbury the proclamation of the President of the United States, inviting the countries of the world to take part in the Chicago Exhibition, and made a formal application, on behalf of his Government, that this country should take part in the Exhibition. Mr. Lincoln at once received the reply that a royal commission should be appointed for the purpose.

No immediate action was taken, but as the result of some informal negotiations, the under secretary of state for foreign affairs, in June, 1891, applied to Sir Richard Webster (who was then attorney-general), the chairman of the council of the Society of Arts, to know whether the council of the society would undertake the duties connected with the organization of the British section of the Chicago Exhibition, if a grant of £25,000 were appropriated by the treasury for the purpose.

The proposal was, in the first instance, submitted to the Prince of Wales, the president of the society, and was approved by him. The council then went very carefully into the question, and came to the conclusion that if the exhibitors were willing, as in the case of the Paris Exhibition of 1889, to contribute towards the expenditure, the grant proposed might be made to suffice. They accordingly requested their chairman to submit a memorandum stating the conditions on which they would be willing on behalf of the society, to undertake the proposed duties.

On July 9, Sir James Fergusson, as under secretary of state for foreign affairs, addressed a letter to Sir Richard Webster, stating that the lords of the treasury would accept the offer of the society to undertake the organization of the British section in Chicago in 1893, and that they had requested the home office to take the necessary steps for constituting the council of the society for the time being a royal commission for this purpose.

The commission was actually issued on August 26, 1891, but in the meantime the council of the society had anticipated their appointment by communicating with the India office and the colonial office, and had requested that the British colonies and the government of India might be informed of the action which Her Majesty's Government proposed to take with regard to the Chicago Exhibition.

The first meeting of the royal commission was held on September 3, 1891. After that date the commission held meetings, all of which have been numerously attended.

As soon as the necessary information had been obtained, circulars were issued to those firms who had taken part in recent international exhibitions, and to a large number of other firms who from their connections with America, or for other reasons, were likely to become exhibitors at Chicago, inviting them to take part in the Exhibition. In all about 25,000 circulars were issued. In the preparations of the lists of persons to receive these circulars useful help was given by Her Majesty's consuls in the United States, who, at the request of the foreign office, returned the names of the English firms having business houses or representative agencies in the various consular districts. Communications were addressed to the mayors and provosts of all towns in the United Kingdom, and application was made to all the chambers of commerce asking them to distribute information throughout their districts, and in many cases suggesting the formation of collective exhibits representing the industries of the locality. Special letters were sent to a selected number of manufacturers who for any reason were considered as likely to become exhibitors. Advertisements were also inserted in the principal English, Scotch, and Irish newspapers. A little later a handbook was prepared and issued gratuitously. As this contained a great deal of useful information there was a very large demand for it.

The limited amount of the grant made by the Government in the first instance rendered it necessary that the amount should be supplemented by charges for the space occupied by exhibitors, and, indeed, the grant was made on that understanding. A sliding scale was therefore arranged under which charges were made for space, the highest being 5s. per square foot of superficial area, the lowest 2s. 6d. per square foot, the amount varying according to the size of the space proposed to be occupied by the exhibitor.

The date by which all applications were to be received was fixed for February 29, 1892. In answer to the circular a large number of applications was received, though it was found that the high customs duties now levied in the United States deterred manufacturers in many important departments of industry from taking part in the Exhibition. Some objections were also taken to the charge for space, but these were not numerous.

When the vote on account came before the House of Commons in committee of supply on March 17, 1892, great exception was taken to the small amount of the grant, and there was a strong expression of opinion from all sides of the House that the sum granted should be largely increased. The commission felt themselves justified by this expression of feeling in urging upon the chanceller of the exchequer the desirability of placing a larger sum at their disposal, especially in view of the fact that the contributions of all the other great countries which proposed to take part in the Exhibition were on a much more liberal scale. As a result of this application the chancellor of the exchequer on April 14, 1892, intimated that Her Majesty's Government were willing to increase the grant to the royal commission from £25,000 to £60,000, on the understanding that space should be provided free to British exhibitors.

The natural result of this liberality on the part of the Government was a considerable increase in the number of applications; and much satisfaction was expressed at the decision of the Government. It was felt that British exhibitors would have been at a serious disadvantage, compared with those of other countries, had a payment for space been added to the very heavy charges which are of necessity incurred by exhibitors at a foreign exhibition.

This alteration in the arrangements rendered necessary a fresh issue of circulars and of advertisements, so that the work of communicating with possible exhibitors was a good deal heavier than in the case of former exhibitions.

The number of applications for space in the industrial sections was 1,010; of these applications 625 were accepted and space allotted to them. It was felt to be more desirable to give extended space to firms who were likely to represent adequately

the industries of the country than to divide up the space available into smaller allotments and thus to satisfy all applicants. It was also considered that only such firms should be admitted as were likely to reflect credit on the country. Had a different course been pursued the number of exhibitors might have been largely increased; but the display would not have reached the high standard it certainly attained.

In order to bring the Chicago Exhibition under the notice of manufacturers in the chief provincial centers of industry and to assist generally in the work, the commission appointed a certain number of committees. The subjects dealt with by the committees were the colonies, India, agriculture and food products, mines and metallurgy, engineering architecture, etc., electricity, transportation, general manufactures, textile manufactures, science, and education. They also, at the outset of their proceedings, addressed an invitation to all the chambers of commerce in the United Kingdom, asking whether they would act as local committees for the Exhibition. From many of these a favorable response was received, and they undertook to disseminate information about the Exhibition.

The collection of works of art for the fine-art section was left entirely in the hands of a committee, of which Sir Frederic Leighton was the chairman. The method of proceeding adopted by the committee was to prepare a list of artists whom it was thought desirable should be invited to contribute, and to ask each of these to name the pictures by which he would prefer to be represented. Application was then made to the owners of the pictures designated, asking for their loan. In many cases the request of the committee was not acceded to, but, on the whole, the owners proved liberal and a satisfactory response was obtained.

In reply to the urgent requests of the American Executive, the royal commission appointed a committee of ladies to prepare a special collection of women's work from this country and to cooperate with the board of lady managers in Chicago. The Princess Christian undertook to act as president of this committee, and to Her Royal Highness' personal attendance at all the committee meetings and the great interest she took in the work must be attributed the large share of success which this department of the British section certainly attained.

Miss Fay Lankester, secretary of the national health society, was appointed secretary of the British ladies' committee, and the efficient way in which she performed the difficult duties of the post fully justified her appointment.

Mrs. Roberts-Austen also undertook the organization of a collection of pictures by English women artists and Miss Helen Blackburn made arrangements for the formation of a portrait gallery of famous women.

A grant of £1,500 was originally made by the commission for the purposes of the ladies' committee; this was afterwards increased to £4,250. The commission also undertook the cost of insurance and freight to and from Chicago of the exhibits under this section.

Two members of the committee, Mrs. Roberts-Austen and Mrs. Bedford Fenwick, went over to Chicago a month before the opening of the Exhibition and remained there, the former for a month and the latter for five weeks. Mrs. Bedford Fenwick's object was to arrange her collection of nursing appliances, while Mrs. Roberts-Austen went out to superintend the decoration of the vestibule.

The royal commission and the ladies' committee are greatly indebted to those two ladies for so earnestly devoting themselves to the interests of this department of the British section.

Mrs. Bond, an English lady resident in Chicago, was appointed superintendent of this section. Mrs. Cope was sent out as assistant superintendent, with special charge of the department of needlework and handicraft. It may be mentioned that the British section in the women's building was complete on the day of opening.

ITALY.

Signor Angelo del Nero, Italian royal commissioner for the fine arts, writes me:

I became interested in the Chicago Exhibition in December, 1889. I began my labors in the fine-art field, and on January 1, 1890, received such a flattering testimonial from the leading artists of Rome that, encouraged by this first effort, I visited, at my own expense, the various industrial and art centers of Italy, lecturing in 14 cities of Italy and visiting also the Italian art colonies of Paris and London. On returning to Rome, at the end of 1890, I found that I had secured several hundred exhibits in the artistic and industrial departments, and had aroused much general sympathy for the enterprise. In January, 1891, I was officially received by the minister of agriculture, industry, and commerce, and explained to him the reasons why Italy should participate in the Exhibition. His reply was cordial and friendly, and he urged me to continue my labors along the lines I had already traced out, but informed me that, owing to the financial condition of the country, he could not ask Parliament for an appropriation, especially as, since the Vienna Exhibition of 1873, Italy had not participated officially in any of the world's fairs. I thereupon closed my studio and sailed for America, where I labored in the interests of the Exposition till December, 1891, when I accompanied to Rome the national commission to southern Europe, sent out by the Exposition authorities. I was then appointed the representative in Italy of the Exposition. I thereupon called a meeting of the artists in Rome and urged upon them the formation of a central art committee. This was done, and Prof. Giulio Monteverde, senator, was made its president, and the body officially recognized by the Italian Government. I then started on another lecture tour throughout Italy, urging the formation of local committees. On my return to Rome in the spring of 1892, the general committee, made up mainly of members of the Roman Chamber of Commerce, was named. This action was so late that it compromised somewhat the Italian industrial exhibit. In February, 1893, I again sailed for America, and my fine-art section was the first of the Italian sections to be inaugurated. Thirty-four medals were awarded to the Italian art section.*

NORWAY.

The secretary of the Norwegian committee sends me this brief report from Christiania:

Our Storthing, or Parliament, voted 241,000 crowns, or about $65,000 for the Norwegian exhibit, and the invitation was received with much favor by that body. The press, too, approved warmly our participation at Chicago, though the general public regarded the matter rather lukewarmly. The consequence was that our important industrial firms almost failed to respond to our call, giving as the reason for their abstention that the McKinley tariff left them little hope of any returns for their sacrifices in exhibiting in America.

Mr. O. Dehli, of the Christiania bar, who had the management of the woman's exhibit, writes me:

The invitation to the Norwegian women to take part in the exhibit at the woman's building was referred to the Norsk Kvindesagsforening, or Norse women's rights society, which immediately took up the matter and made it known all over the

*On reaching home in the spring of 1894, Signor del Nero was knighted by King Humboldt, being made chevalier of the Crown of Italy, the only member of the Italian commission to receive this high honor in connection with the Fair.

country through the daily and periodical press and by means of circular letters. The society collected in various parts of the country such articles as were characteristic of Norway, and before forwarding them to Chicago exhibited them in this city. The society's budget for this purpose, including the funds voted by Parliament, was about $1,100, and the total value of the exhibit was estimated to be $2,275. In connection with the exhibit, the society published a pamphlet entitled "The Legal and Social Condition of Norwegian Women."

PORTUGAL.

Gen. George S. Batcheller, formerly United States minister at Lisbon, writes:

The part taken by Portugal in the Chicago Exposition was so insignificant as to be scarcely worthy of mention. As the representative of the United States it was my duty to communicate to the Portuguese Government the official invitation to participate in the Exposition, and I laid before the several ministers the various documents forwarded for their guidance and instruction in case Portugal should accept. I also called personally upon the ministers of foreign affairs, commerce, and marine, and urged upon them the special considerations why Portugal should be represented at Chicago. I directed attention to the discoveries on the Western Continent by Portuguese navigators, and especially expressed a desire that certain charts and maps made by these adventurous voyagers should at least be displayed in the geographical section of the Exposition. Great interest was, at first, manifested by the Portuguese authorities and ready assurances given of a favorable decision, but all these plans were rudely negatived by the minister of finances, who frankly declared that the treasury could not afford the expense, and soon after I received a formal declension from the foreign office, based upon the straitened condition of the treasury, which I duly forwarded to the Secretary of State at Washington. Later on, at my request, the Portuguese Government delegated its minister at Washington as a special representative of Portugal at the International Congress held at Chicago as an auxiliary of the Fair. After this official failure I attempted to interest various individuals and societies to send exhibits and representatives to Chicago. This invitation was taken up by the geographical society of Lisbon, which voted to send delegates to the geographical section of the congress and to forward certain historical documents relating to early American discovery.

I was aware that the King, Don Carlos II, had sent to the Columbian Exposition at Madrid certain precious documents consisting of the early charts of the great navigator, Vasco de Gama, and historical works belonging to His Majesty's private collection. I therefore called upon the King and urged upon him the propriety of loaning this collection to Chicago. His Majesty readily consented and promised that as soon as the Madrid Exposition closed the collection should at once be shipped to the United States. I also saw Dona Eugenia Telles de Gama, lady of honor to Her Majesty the Queen Dowager Maria Pia, the descendant of the famous navigator, and secured from her a promise that certain charts, maps, and objects connected with the career of her ancestor and still remaining in the family should be added to the royal collection. But whether any of these articles ever reached Chicago I am unable to say, as I left Lisbon before the Madrid Exposition closed. But I fear, like many other matters in that sadly impoverished country, there was little else than promises as the fruit of my efforts.

In private commercial departments there were more satisfactory results. While in Madeira in the spring of 1891, I received the promise of several wine merchants and producers to send samples of their products to the Fair. I also made like efforts at Oporto; and I think the wine and cork industries of Portugal were quite creditably represented at Chicago.

I also took some pains to collect and send to the Bureau of the American Republics at Washington photographs of Lisbon and the river Tagus, showing the little port where Columbus is reputed to have landed when he visited that city, and I had taken especially a photograph of the church of Santos, standing on the site where Columbus was married.

RUSSIA.

The Hon. Andrew D. White, who was United States minister at St. Petersburg from 1892 to 1894, writes:

My immediate predecessor[a] and myself had considerable to do in connection with Russia's participation in the Chicago Exposition. Not only the general circulars but a multitude of special circulars in various departments of the Exposition were sent out, and to these the attention of the proper authorities under the Russian Government was steadily called.

The Government itself was led to send a large and important commission in which were a number of men known as devoted to various special fields of labor and thought represented at Chicago.

The Emperor himself, at various times, showed much interest, and when I was presented to him on my arrival, and once or twice afterwards, asked many questions regarding the great enterprise. The same is true of the Empress, who informed me that she had herself contributed various pieces of art workmanship to the department of woman's work.

The only effort which had but partial success in securing Russian cooperation was that which tried to induce the Russo-Greek Orthodox Church to send delegates to the parliament of religions. Under instructions from the United States Government, I had many conversations with Mr. Pobedonostzeff, the procurator of the Holy Synod, who at last seemed to think not unfavorably of the general plan, but parochial difficulties arose from the want of a prelate who could take part in the proceedings in the English language.

Still, Russia was admirably represented in this congress by Prince Lerge Wolkousky, who, though the delegate of the department of education, took part in the religious conferences with great effect. I exerted myself, especially by letters, to bring him into relations with influential men in various parts of the country, and I think that no one from abroad has for many years studied American education, especially in the universities, with more intelligence than he. He made visits of some length to Harvard, Columbia, Cornell, and Stanford universities, entering very heartily into the life of these, and indeed into that of many other seats of higher education.

As to the department of woman's work, a very marked impression was evidently made by the Princess Schabovskoy, one of the Empress's maids of honor, who was sent over to take the leading part in this field. This she did to excellent purpose, and has established a dépôt for Russian needlework and the like, which seems likely to be a great success.

In the field of engineering in its various branches, Russia sent a number of eminent men, whom I aided with letters to get into proper relations with the men whose acquaintance seemed to me most desirable for them.

SPAIN.

In Spain, four different decrees were issued appropriating money for the Exhibition. The whole amount attained 1,555,000 pesetas. Spain, Cuba, Porto Rico, and the Philippine Islands were represented by 3,066 exhibitors. At the head of the executive committee was placed the Duke of Veragua.

[a] Hon. Charles Emory Smith.

SWEDEN.

The Swedish commission appointed by the Government had at its head Richard Akerman, of the royal board of commerce, and its members embraced officials and manufacturers of high repute. The royal commissioner was Arthur Leffler. The number of Swedish exhibitors was 345. The woman's exhibit was under the special patronage of the Queen. The exhibits were selected with great care and were very representative of the country. The Government appropriation amounted to nearly $100,000. Mr. Arthur Leffler writes me:

The exhibitors were exempted from all expenses relating to transportation, insurance, installing, and guarding, and consequently had only to defray the cost of producing the exhibits. A few of the exhibitors themselves managing the instalment of their exhibits, the contribution given by the exhibitors may be valued at about $20,000.

SWITZERLAND.

M. James Perrenaud, the Swiss federal commissioner for Chicago, writes:

The appropriations voted by the Swiss Federal Government were: For the watchmaking industry, 120,000 francs; for the wood-carving industry, 50,000 francs; for other industries, 15,000 francs; total for industries, 185,000 francs; for jurymen's expenses, 30,000 francs; for delegates' expenses, 60,000 francs; total federal appropriations, 275,000 francs. In addition, the Cantonal authorities of Neuchatel, Geneva, and Berne contributed 45,000 francs, which, with the federal appropriations, make a grand total of 320,000 francs, or about $64,000.

The Federal Government furthermore recommended an appropriation of 40,000 francs for the special woman's exhibit, but as the woman's committee did not furnish satisfactory explanations as to the nature of their exhibit, the money was not voted, and the committee made no exhibit.

The commissioner was appointed November 1, 1892, that is only six months before the opening of the Fair, so that there was not time enough for some of our larger industries to prepare their exhibits, and they were, consequently, not represented at Chicago. We did the best we could with those industries which were able to prepare the quickest exhibits, as a proof of good feeling and warm sympathy for the enterprise and for the great sister Republic of the United States.

As to my personal impressions, I may add, in the words already embodied in my report to the federal council, that the World's Fair was the grandest exposition of the century, and a great success in every way, of which the United States may be rightly and justly proud. It is most probable that in the history of enterprises of this kind that of Chicago will remain the typical feature of the grandiose. I must add that I shall always remember the high courtesy shown to the Swiss commissioner by the American authorities and officials of the Fair, and for which I am most grateful.

TURKEY.

The Hon. Z. T. Sweeney, formerly United States consul-general to Turkey and Honorary Imperial Ottoman Commissioner to the Chicago Exposition, writes me:

I did all I could to advance the interests of the undertaking by publishing in the Constantinople papers the information sent me by the Exhibition authorities, and

by disabusing the public mind of the idea that New York was the only place fitted to hold such a Fair in. This was the universal sentiment at the beginning of the enterprise. I heartily cooperated with Professor Adler.

Prof. Cyrus Adler, then associate in Semetic languages at Johns Hopkins University and assistant curator of oriental antiquities in the United States National Museum, and now, besides the last-named post, librarian of the Smithsonian Institution, gives me the following account of his work in Europe for the Fair:

On August 19, 1890, I presented to the committee on foreign exhibits of the board of directors, at the suggestion of members of the national commission, a memorandum concerning an exhibit representing Turkey in Europe, Syria and the Arabic peninsula, Egypt, and Persia. This memorandum was divided into two parts. The first suggested a realistic exhibit of the eastern countries named, and the second, a scientific exhibit representing the civilizations of Assyria, Egypt, and Persia. As no appropriation was made for the scientific exhibit, that portion of the plan had to be given up.

Through the kind offices of the United States legation at London I was presented to the Ottoman embassy at that place, and discussed with them the matter of the representation of the Ottoman Empire. I arrived at Constantinople in the middle of December and consulted with Hamdi Bey, the director of the imperial museum, and with Tewfik Bey, the director of the Museum of Janissaries and of the Technical School of Constantinople; but though these officials expressed themselves very favorably toward the Exposition they were unable to make any definite statement. Meanwhile the United States minister, the Hon. S. Hirsch, brought the Exposition unofficially to the attention of the grand vizier. As soon as the invitation arrived I again communicated with the officials named above and secured a definite promise of their cooperation.

The invitation and instructions, having been translated into French and Turkish, were officially presented by the United States minister to the Ottoman minister of foreign affairs, and I was then presented to this official as well as the grand vizier. Both of these officers stated that while they felt assured that their Government would like to be represented, no large expenditure could be incurred at this time for such a purpose, and requested that I should endeavor to make arrangements whereby a creditable Ottoman exhibit might be installed without considerable expense to the Government.

I was enabled, through a secretary of the Sultan, to bring the Exposition to His Majesty's attention, and early in March, at least two months and a half before the official acceptance of the Turkish Government, the Sultan gave orders for the collection of certain objects for the Columbian Exposition. These objects included a complete series of all the works issued in the Ottoman Empire during the reign of the Sultan, and a set of photographs of the exterior and interior of the Turkish governmental buildings.

On June 9 the Sultan signed an irade, accepting the invitation and appointing a commission, consisting of members of the chamber of commerce, to sit under the presidency of the minister of commerce and public works, and to meet and consult with me as to the nature of the Turkish exhibit. With this commission I sat from June until the middle of September. Meanwhile the chargé d'affaires of the United States, Mr. Francis A. MacNutt, took opportunity, at a public gathering at which he was invited to speak, to call especial attention to this woman's department of the Exposition. The first dragoman, Mr. A. A. Gargiulo, also did good work for the Exhibition.

NETHERLANDS.

Hon. William E. Quinby, minister to the Hague, writes:

My predecessor, the Hon. Samuel R. Thayer, exerted his personal influence to move the Government to respond to the various invitations from Chicago, and urged upon industrial houses the benefits to be derived from their participation in the exposition.

The country was visited again and again by delegates from the many branches of the Exposition, to whom all possible aid was afforded toward promoting the success of their missions; and, further, the applications from presidents and secretaries of the Congressional committees for papers on Netherlands' affairs received prompt attention, every endeavor being made to secure interesting matter for the sessions.

The Hon. Samuel R. Thayer, formerly United States minister to the Hague, writes me:

The President's communication to the Netherlands Government, inviting its participation in the Columbian International Exposition, did not meet with a favorable response until months after it was delivered. While there seemed to be no apparent want of interest in the enterprise, either on the part of the leading officials of the Government or the public, the King's cabinet was indisposed to take official action on the subject, because an acceptance of the invitation would be in violation of the traditional policy of the Government with reference to invitations of this character, as well as a manifest discrimination in favor of the United States against other peoples.

After several months' reflection, however, the reasons in favor of its acceptance prevailed with the ministry, and an unqualified expression of the same was communicated to the Secretary of State through the minister of foreign affairs. This action was followed by an appeal to Parliament for an appropriation of money to this end. A small sum was finally voted, after much wrangling and debate in the second chamber. Public interest was stimulated in a marked degree by reason of the indorsement thus given, and as a result there was a creditable exhibition of art and most of the leading industries of the country.

On February 18, 1892, Mr. H. W. Mesdag, a leading artist at the Hague, was appointed the Dutch art commissioner; in the following June a committee was formed consisting of leading officials and merchants, and in July a woman's committee was named embracing such distinguished ladies as Baroness van Zuylen van Nyevelt and Countess van Hogendorp.

THE VARIOUS SPECIAL MISSIONS.

Besides the work of Professor Adler, already mentioned at some length, and that of one or two other similar agents briefly referred to in the foregoing pages, several more special missions call for a word.

Two official commissions were sent to Europe in 1891—the first in the summer, consisting of five members: Hon. Benjamin Butterworth, Maj. Moses T. Handy, Ferdinand W. Peck, esq., Senator William Lindsay, and A. G. Bullock, esq. Their mission was mainly to northern Europe, and was eminently successful. From their report of September 24, 1891, are extracted the following conclusions:

In their visit to the several governments of Europe the commissioners endeavored

not only to explain the scope and plan of the Exposition, the ways and means provided for an exhibit of those material things which evidence the progress of civilization in the industrial arts and applied sciences, but they also called attention to the arrangements that are being made to illustrate the advancement in the moral, intellectual, and social worlds; that a series of congresses would be held during the Exposition season, and that at these congresses the important problems of the age, social, scientific, financial, and economic, would be discussed by the foremost thinkers and writers of the United States and other countries.

It was gratifying to observe that the liveliest interest is taken by all the nations in this branch of the Exposition, they realizing that the mission of the convocation of the nations had a purpose above and beyond the mere matter of promoting the barter and sale of merchandise.

Attention was also called to the women's department, presided over by Mrs. Palmer, who had recently visited several of the leading capitals of Europe, where she had done most excellent work, which the commission was able to supplement.

The success of the commission was in a large measure due to meeting personally those in authority at the different capitals, and explaining in detail every matter pertaining to the Exposition concerning which information was desired; and, subsequently, having full and free conferences with the commissioners appointed to have charge of the interests of the nations they severally represent.

Beyond that, the visit by the commission was accepted by the nations as an expression of good will by the Government and people of the United States, which was reciprocated in a manner that secured for the commission a cordial reception and a friendly hearing.

Sir Henry Trueman Wood says of the labor of this commission:

Their visit was of great value in providing information as to the general scope and character of the Exhibition and of the organization which was provided for carrying it out.

In Paris the commissioners were entertained at dinner by M. Yves Guyiot, minister of public works, and Minister Whitelaw Reid; and at breakfast by M. George Seyer, director-general of the Exhibition of 1889; while they called by appointment on Senator Charles Floquet, then president of the chamber of deputies, and had frequent business interviews with the French officials who had special charge of Exposition interests.

The second commission was to southern Europe and was composed of only two members, Hon. Thomas B. Bryan and H. N. Higinbotham, esq., both active and zealous in France and Italy. But on the latter's return to America Mr. Bryan alone represented the commission during much of its important work. It was at this time, in February, 1892, that he was received in audience by Pope Leo XIII, and secured the pontifical letter which was published in all the principal languages and countries of the world, and elicited favorable comments from the Protestant as well as the Catholic press.

Mr. Bryan was in Paris twice during his mission. During the first visit, accompanied by Mr. Higinbotham, they were entertained at breakfast by M. Jules Siegfried, deputy for Havre and later minister of commerce, M. Georges Seyer being one of the guests on that

occasion. The breakfast was followed by a drawing-room meeting in which Exposition interests were promoted. Mr. Bryan and Mr. Higinbotham received several other social attentions and met many influential manufacturers and officials.

Speaking of his labors outside of Paris, Mr. Bryan says:

During the five months of service as president of the commission to southern Europe, and especially in Rome, Greece, and in the Balkan Peninsula countries, I succeeded in inducing the rulers, the kings, and the Pope to reverse their avowed intention to abstain from any participation in the Fair, because it was "too remote," etc. King Humbert, the Pope, and, indeed, all the ruling powers in southern Europe, were of that mind and so frankly avowed it promptly but politely. But I persisted, after my brother commissioner returned to America, and was rewarded not only with the Pope's letter and gifts as souvenirs of the official visits, but also with magnificent contributions that came to the Exposition in answer to the urgent appeals.

Sir Henry Trueman Wood thus speaks of Mr. Robert S. McCormick's mission:

In order to assist in spreading information about the Exposition in England and in Europe the American executive, in the autumn of 1891, established an office in London and appointed Mr. Robert S. McCormick commissioner for Great Britain. Mr. McCormick had for some time held the office of second secretary in the United States legation in London, and was consequently well known, so that he was enabled usefully to cooperate with the royal commission in disseminating information as to the Exhibition and in attracting attention thereto. On April 6, 1892, he read a paper on "The future food relations with Great Britain and the United States," and for it the society of arts awarded him a medal. Mr. McCormick's mission terminated in the autumn of 1892, and the office was closed.

Shortly after the passage of the act of Congress authorizing the Exposition and locating it at Chicago, the Latin-American department was organized under the direction of William E. Curtis, who proceeded at once to enlist the services of the diplomatic and consular officers of the United States all over the world in securing articles and collections for the historical exhibit. In the fall of 1892 he made a journey to Europe himself, visiting England, France, Spain, and Italy for the purpose of obtaining loans from public and private collections to enrich the historical section of the Exposition that was exhibited in the Convent of La Rabida. Mr. Curtis secured the passage of a resolution by Congress requesting loans from the Pope of Rome, the several sovereigns of Europe, from the Duke of Veragua, from the Duke of Berwick Alba, and other fortunate possessors of historical mementoes, and carried with him formal applications from the President of the United States under such authority. His mission was eminently successful. He secured every existing relic of Columbus, and large historical collections illustrating the knowledge of geography at the time of the voyage of Columbus and the progress of civilization in the western world during the century that followed.

Mr. Curtis also secured an appropriation from Congress for the

reproduction of two vessels of the fleet of Columbus, and by skillful negotiation induced the Spanish Government to build a facsimile of the third. This fleet was one of the most interesting objects at the Exposition, and will remain permanently in Washington.

Capt. Frank H. Mason, consul-general at Frankfort, one of the oldest and ablest agents of the State Department, gives me this accou of his work:

In June, 1891, I was instructed by the Department of State to visit St. Dié, in the department of Vosges, France, and obtain for the historical department of the Columbian Exposition all possible details of the history of the place, where was published in 1807 the little book "Cosmographiæ Introductio," which first gave the name "America" to the Western Continent. I went there, obtained a large number of photographs, engravings, portraits, etc., which were used to decorate the room which was devoted to St. Dié in the Convent of La Rabida at the Columbian Exposition. I wrote also an account of the Cosmographiæ and its authors, which was published in the October number, 1892, of Harper's Magazine, and was afterwards used, with its illustrations, in the official catalogue of the Rabida.

In July, 1891, I went to Venice, where I found by accident the original portrait of Columbus painted by Lorenfo Lotto, which I had been requested by the chief of the historical department at Chicago to find and obtain a copy of. I purchased the original painting and afterwards transferred it to James W. Ellsworth, esq., one of the directors of the Exposition. It became the recognized portrait of Columbus in America, was copied on the badges and diplomas of the Exposition, as well as on the $4 Columbian postage stamp, and when exhibited by the United States Government at the Columbian Exposition in Madrid, during the winter of 1892–93, received the medal as the best and most authentic portrait of Columbus.

During the summer of 1891 the special commissioners of the Exposition visited Frankfort, and spent several days there at the World's Electrical Exposition, which was then in progress. This consulate gave them all possible assistance in meeting exhibitors and securing their attendance and cooperation at Chicago. This office also distributed a large number of circulars, illuminated maps, posters, etc., as well as instructions to exhibitors, and during a period of eighteen months maintained a correspondence with intending exhibitors concerning the details of classification, shipment, conditions of free entry for exhibits, etc.

During the spring of 1892 I spent several days at the Horticultural Exposition at Carlsruhe, and worked by personal solicitation, and at a special meeting of exhibitors there, to secure their attendance as exhibitors at Chicago. I made a report on that exposition to the chief of the horticultural department of the Columbian Exposition, giving the results of my efforts at Carlsruhe, and for this and other services I was appointed, with the approval of the Secretary of State, honorary commissioner for the Columbian Exposition to Germany. I also helped to secure, as special exhibits at Chicago, Consul Partello's unique collection of old Italian violins, and the Marfels collection of historical watches.

I also attended numerous meetings at the chamber of commerce in Frankfort and elsewhere, which were held to organize exhibitors and stimulate interest in the Columbian Exposition, and in general did all in my power, during a period of two years, to advance its interests by securing exhibitors and visitors from this portion of Germany.

Prof. Halsey C. Ives, head of the art department of the exhibition; Mr. Willard A. Smith, head of the transportation department; Mr.

Geo. H. Wilson, secretary of the musical bureau, and other officials of the Exposition visited Europe in the interests of their respective departments.

Several special treasury agents—ex-Congressman Grosvenor of Ohio and Maj. Frederic Brackett, not to mention others—also did good service, outside of their immediate duties, to awaken interest in the Fair and remove prejudices or misunderstandings.

Mr. H. H. Kohlsaat, one of the directors during the first year of the organization, went to Europe in October, 1890, with the title of honorary commissioner, and was thus the first representative of the Fair in Europe. He attended the first meeting of the Society of Arts in London that took up the Fair, when Mr. James Dredge read a paper on the proposed enterprise, at the close of which Mr. Kohlsaat made a few remarks and answered questions put to him by the members of the society.

Mrs Potter Palmer's two visits to Europe, the first in the summer of 1891 and the second a year later, were in many respects the most notable efforts made on the part of the officials of the Fair to awaken interest in Europe. Mrs. Palmer was received by royalty, by M. Carnot at the Elysée Palace, and by leading officials in various capitals, and she met distinguished ladies of the nobility and earnest workers in various departments of feminine activity. The result was seen at the Woman's building in Jackson Park. Mrs. Potter Palmer writes me as follows:

> We appealed to quite a different class of persons from those ordinarily connected with exposition work. The most influential persons in official, social, professional, and expert circles were associated on our foreign committees, and the work was based on original investigation which would tend to explain unrecognized or misunderstood phenomena and cause the gradual amelioration of unfavorable conditions and sentiments and uplift humanity. We were engaged in a study of social problem, and feel that we have developed certain very interesting features and opened the way for valuable work in the future. The prompt and sympathetic response showed that foreign women are as much absorbed as ourselves concerning the questions of the hour and the ability with which they carry out their plans, and the original and independent investigations which they undertook and perfected show their admirable training and equipment.

Mrs. May Wright Sewall successfully seconded Mrs. Potter Palmer's labors. She, too, went to Europe twice in the interest of the woman's congress. She, too, was received by members of royal families, lectured in public and spoke in private, and contributed not a little to make the congress of eminent women probably the most successful, as it certainly was the most enthusiastic, of that long and brilliant series of international gatherings.

Nor must the good work performed by Major Handy's bureau of publicity and promotion be forgotten in this catalogue. Mr. R. E. A.

Dorr, now publisher of the New York Mail and Express, and who was head of the bureau during its chief's mission abroad, writes me:

Just as we were beginning our work in foreign lands the carrying out of that work devolved upon me. I established communication through American diplomatic representatives and consular agents with manufacturers and prominent citizens in every country in the world. I sent to these people in their own language a weekly or semiweekly news letter telling what was being done in Chicago and in the United States in the way of preparation for the great Exposition. I did not allow these letters to exaggerate in a single instance. The facts were great enough in themselves. I sent to every country on the globe a number of those large lithographs showing a bird's-eye view of the Exposition buildings and grounds. It is needless to tell how great was this work. That our efforts were successful is best attested by the splendid showing of foreigners at the Exposition—by the splendid exhibits they made.

FARMING TOOLS, IMPLEMENTS, AND MACHINERY.

BY

CALVIN YOUNG, Judge.

FARMING TOOLS, IMPLEMENTS, AND MACHINERY.

By CALVIN YOUNG, *Judge.*

I. LOCATION OF EXHIBITS.

The implements of agriculture was allotted space in the agricultural building. The main part of this building was 500 by 800 feet, modeled after the style of the Spanish renaissance, and was one of the most sightly of the palaces of the Exposition. Its greatest length fronted the main court. Its principal entrance was more than 60 feet wide, and opened into a rotunda 100 feet in diameter, which was covered by a glass dome 130 feet high. It was a magnificent edifice, perfect as a work of art.

Adjoining this building was a large annex, 312 by 550 feet. This annex was given up wholly to agricultural machinery. This great space—much larger than had ever been allotted to the implements of agriculture in any of the other great international expositions, was far from adequate for the accommodation of the different varieties of farm tools for which space was sought, and while the leading manufacturers of America were given enough room to show the machines that they build and sell, still they were so restricted that any implements containing advanced ideas in the experimental stage could not be shown. Traction engines for farm use, wind engines, grinders, pumps, and those appliances that are given motion by wind mills, occupied a large area of ground to the south of the annex.

The 5,000,000 square feet under roof—twice as much as the greatest Exposition of the past—the buildings being located in an area of 645 acres, three times the space of any previous exposition, made it possible to allot to agricultural machinery the $3\frac{8}{10}$ acres in the annex and the acres of open ground stretching away to the south around the head of the south pond. The machines of agriculture exhibited at the World's Fair at London, in 1851, occupied less than one-thirtieth of the space devoted to the same line of machines at this Exposition.

II. EXHIBITS OF FOREIGN GOVERNMENTS.

Of the foreign governments, Canada occupied a space as great as all others combined. It had an advantageous location, and made a beautiful exhibit—one worthy of its agricultural position. Its 7,500 square

feet of space was filled with a complete line of implements, modern in style, symmetrically designed, and closely resembling the machines of the same type shown by the exhibitors of the United States. The exhibit of Germany was next in importance. Its 4,000 feet of space was well filled. Its machines lacked the high finish, the symmetry of design, and the perfect adaptability for their purpose that characterized the implements of the same classes throughout the annex. France was allotted a space a little larger than that of Germany. No implements of agriculture were shown, the space being only partly filled by a model of a well-arranged farm. Russia did better, and exhibited, more particularly in plows, a sample of the tools of their manufacture. Sweden was the only foreign country, with the exception of Canada, that showed a mowing or reaping machine. In the exhibit of that country, in the main body of the agricultural building, there was a one-horse mower. Ceylon had a collection of the hand tools of agriculture in its exhibit, as did Italy, Mexico, and some other countries. The remaining space of the annex—more than nine-tenths of the entire space—was filled with the products of the factories of the United States. Brightened with banners and draperies, machines finished in gold and silver and others artistically painted, most of which were in motion, enlivening the scene, the implement annex presented such an attractive appearance as to be constantly filled with sightseers.

III. ANTIQUITY OF AGRICULTURE AND AGRICULTURAL METHODS.

In panels above the north entrance of the agricultural building were names famous in agriculture. They began with Hesiod and ended with Pliny. The time in which these men lived extended over a period of about nine hundred years, ending A. D. 32. When the agriculturists of the valley of the Mississippi read these names, they wondered why they were there, and remarked on the absence of the names of modern agriculturists, forgetting that agriculture has been practiced from the earliest time, and that it was one of those whose names were on the building who wrote: "Nothing is better than agriculture, nothing more beautiful; to a free man nothing more worthy of his attention." Throughout the Bible Egypt is referred to as a land so rich in corn (grain) as not only to produce an abundance for its great population, but to yield large supplies for exportation. The rotation of crops was understood in those early times. Manures were known, irrigation was practiced, and drainage was particularly attended to by the Romans. Pliny says:

> The more diligent husbandmen plough five times for the napus (turnip), four times for the rapa (rape), and applied dung to both.

They understood the practice of plowing under living crops for the sake of fertilizing the land, and they confined their cattle in large

sheds at night, whose floors were covered with sand or earth to absorb the liquid manure. The same beasts of burden were in use by the Romans as are used to-day, except that the horse was raised more exclusively for the saddle and war. The oxen were used mostly in pairs and upon the plow and cart.

IV. ANCIENT AGRICULTURAL MACHINES.

From the descriptions of the ancient writers, it is very probable that there were plows with and without moldboards, with and without colters, with and without wheels, and with broad and narrow-pointed shares. But they were formed of wood and were, of course, far from being scientifically constructed. The wooden plows of Egypt, Italy, and Mexico of to-day, and the wooden plows shown in the Siamese pavilion in the main body of the agricultural building, fully answer to the descriptions of Pliny and Virgil. For three thousand years the plow seems to have remained practically without improvement. The wooden shares were fashioned from time to time somewhat differently, and the moldboards given varying curves. The points were protected by iron and the moldboards by iron straps. Wheels were placed on axles beneath the beams, and curved sticks were projected in front of the plow and attached to the beams to act as cutters or colters. But not until the present century were the improvements made which have resulted in the symmetrical iron and steel plows of this day. The urpex of the Roman was a plank filled with teeth and used as a cultivator to break rough ground, while the "crates" is figured out by those who have given attention to the matter to have been a harrow. In Gaul, Palladius tells of a quick way of reaping by means of a box carried on wheels, to one side of which are fastened a large number of small teeth, like the teeth of a comb. This box was pushed against the standing wheat by an ox, and an attendant with a stick beat the heads of grain that had been stripped from the stalk by the teeth back into the box. Varro tells of a sort of a thrashing machine used in the Carthaginian territory, which consisted of several rollers placed together in a frame, which rollers were studded with projections, and by means of an ox the framework was drawn over the grain that was spread upon the ground or thrashing floor. These are the crude devices of agriculture worked by cattle, and are all that we know of in use among the ancients, and of these the gleaner for the heads of grain and the frame with the studded rolls for thrashing disappeared from use shortly after the beginning of the Christian era. The reaping hook seems to have been the same as that in modern use. The spade, hoe, ax, adze, and rake were hand tools similar in shape to those in use at the present time. The high state of agriculture of the Netherlands and Holland during the Middle Ages was one of closer cultivation of small plots of ground,

which they brought to a high state of productiveness, cultivating by hand all of the then known vegetables and grasses. The economy and frugality of the people doing their work without hired help, and with but few draft animals, without any but the more simple farm tools, such as the spade, hoe, and rake, made these lowland regions one vast garden. The English writers on agriculture who went to the Netherlands in the middle of the seventeenth century to report on improved forms of agriculture, after telling of the grasses and vegetables they saw cultivated, speak of an improved plow, calling it the "Rotherham" plow, and this plow was the basis of the improved Scotch plow, which every Englishman thinks is the best in the world. With this exception there is no account of an improvement in agricultural implements from the beginning of the Christian era to the discovery of America.

V. IMPORTANCE OF AGRICULTURE AS AN OCCUPATION.

A comparison of the importance of agriculture with that of other occupations will, in whatever era the comparison may be made, show in a striking way the great proportion of the people of civilized lands that are engaged in the growth of food products. Among the ancients the raising of food products, war and government, were the occupations of the people. The great proportion of the people were for 1,800 years engaged in the raising of food products, and this statement is true to-day in all but a few of the most highly civilized countries. In the United States the farms averaging 137 acres each are valued at nearly $14,000,000,000, and there are 4,564,641 of them. Add to the value of the farms the implements and domestic animals, which average more than $1,000 per farm; thus over $18,500,000,000 is invested in agriculture. The farm family with hired help averages 6 persons, and we have therefore 27,387,846 persons engaged directly in agriculture, out of a population of 65,000,000. In 1890 the product from these farms was $2,460,107,454, and in 1895, even with the great decrease of values in farm products, it is estimated that the amount will reach $2,300,000,000. During the fiscal year of 1895 the United States exported to foreign countries domestic commodities, merchandise, and products aggregating $793,000,000, and the aggregate value of the products of agriculture included in that sum was $553,215,317, or 69.68 per cent of the whole. In other words, the 42 per cent of the population feeds itself and the other 58 per cent, and then furnishes 69 per cent of all the exports of the whole people. In 1890 the farm lands of the United States, in tilled and productive fields, amounted to 357,616,755 acres, so the products of the 5½ acres to each inhabitant, less the consumption for animals, would have to be consumed if there were no foreign market. Should the farm lands of the United States become as productive by careful cultivation as the 54,000,000 cultivated acres of France, which according to Bulletin No. 6, 1891, minister of agriculture of France, produced $3,800,000,000 of products, the

United States would produce food sufficient to feed all of Europe. This same bulletin values the productive farm lands of France (less than one-seventh the number of acres of those of the United States) at $18,300,000,000—about $4,000,000,000 more than the productive farm lands of the United States are valued at, according to the report of the Commissioner of Agriculture for the year 1895. In Germany more than one-third of her 50,000,000 inhabitants are supported by agriculture, and about one-half of the entire area of the German Empire, about 65,000,000 acres, is classed as arable land. As in France, the size of the farm is very small. Our farmers would call them minute. There are 2,500,000 in the German Empire that are less than 2½ acres, and as many more less than 25 acres. While it is true that the agriculturists of England have decreased in the last decade, and the inhabitants of the cities increased in a remarkable ratio, more than 15 per cent, still there is no single occupation in Great Britain whose product equals that of her farms, and no two that engage so many of her inhabitants. The tendency of agriculture in England is toward small allotments of ground, there having been 455,000 allotments of less than 1 acre granted up to 1891. This must mean a tillage by the spade and hoe, a system of market gardening, and the raising of poultry.

The importance of the transportation of the food products of the world from the farm to the consumer in the town, and from the town to the neighboring cities, from the city to the seaboard, and the seaboard to the inhabitants of foreign cities, constitutes the greatest factor in transportation at home and commerce abroad. The railways of the United States, representing $10,000,000,000 in capitalization, the immense commerce of the Great Lakes and the ocean steamship lines, would be in the hands of receivers in a short time were the carrying trade of our food products taken from them. Our 185,000 miles of railway—as many miles as exist in all the rest of the world—are taxed at certain periods of the year in transporting the products of the farm. It is our food products that have perfected a most complete system of navigation by lake and canal, and have forced a banking system by which a uniform and stable currency exists throughout the entire country. It only needs now a cooperation of our agricultural community in the building of good roads to place the product of the farm with the cheapest possible cost in the home of the consumer.

VI. CLASSIFICATION OF THE IMPLEMENTS OF AGRICULTURE.

Group 16 at the World's Columbian Exposition included six classes: Class 85, implements of tillage, were on exhibition in the form of manual implements, such as spades, hoes, rakes, and cutting knives. This class also included power implements of tillage, such as plows, cultivators, clod crushers, harrows, and horse hoes. Class 86 took in the planting instruments. These were manual, such, for instance, as

hand corn planters, drills and seeders, while the power machines, animal and steam, included the grain and fertilizing drills and corn planters. Class 87 included the harvesting machines. These included the manual implements, such as scythes, rakes, forks, grain cradles, and sickles; while the power machinery included reapers, binders, headers, corn harvesters, rice harvesters, mowers, rakes, hay elevators and loaders, and potato diggers. Class 88 included the machines necessary to prepare the crop for marketing, such, for instance, as thrashers, clover hullers, corn shellers, winnowers, and baling presses. Class 89 included those farm tools which come under the head of economical devices, such, for instance, as portable and stationary engines, windmills, hay and feed cutters, vegetable cutters, feed grinders and corn drills, farm boilers, steamers, and incubators. In class 90 was included anything applicable to transportation on the farm, such, for instance, as wagons, carts, traction engines, and more particularly apparatus for road making and excavating. In these six classes 254 different exhibitors made entries, and of this number 252 were North American manufacturers. Ceylon, Denmark, Italy, and Uruguay each had but one exhibitor, while Germany had 14. Austria, Australia, Belgium, Cape of Good Hope, Ecuador, Great Britain, India, Japan, the Netherlands, and Spain had exhibits in the agricultural building, but made no entries in any of the classes of agricultural implements contained in group 16. France occupied a large portion of its space with a model farm, with granaries and farm buildings. Two hundred and ten of the North American exhibitors were from the United States. While it was to be expected that the pride of home manufacturers would send a complete representation of their different articles of manufacture, still it was hoped that the manufacturers of Great Britain and France, with the same courtesy that had carried the leading American inventions to their great expositions ever since 1851 and 1855, would have made as creditable a representation of their farm machinery as possible.

It is noticeable that the exhibits of the foreign countries were largely of special forms of apparatus; for instance, Denmark's sole exhibit was a yeast-manufacturing device; and from Sweden a centrifugal winnower; while from Germany were watering engines, manure-kneading and compounding machines, barley sieves, potato harvesters, and drill and fertilizing machines. Among the classes of the exhibits of the United States and Canada, the planting, harvesting, and thrashing machines were most prominent.

VII. METHOD OF GRANTING AWARDS ON AGRICULTURAL EXHIBITS.

In a speech made to the American exhibitors by John Boyd Thacher, chairman of the executive committee on awards, and delivered at the music hall in Jackson Park on August 12, 1893, Mr. Thacher said:

There are three great steps in an international exposition. The first is the selection of the site and the erection of buildings; the second is the gathering and instal-

lation of exhibits, and the third is the pronouncing of judgment upon exhibits within the Exposition gates. I indulge in no language of exaggeration when I say that in ancient or modern times the eye of man has never rested upon such a magnificent aggregation of buildings as is presented here directly in front of the administration building in Jackson Park. And I believe it is true in respect to the second great step; that there never has been brought together such a fine collection of exhibits, so representative of our present advancement and culture, so instructive of the progress the world has made in the arts, industries, and sciences. And yet in less than three months from to-day the workingman's busy hand will begin to tear down what it took so long to fashion and build. Three months more and the exhibits which are here installed will be carried away and dispersed to the four corners of the earth. It is certain that there is no one person now before me, certainly no one sight-seer, who has ever seen 5 per cent of the exhibits within these grounds, for there are between four and five hundred thousand distinct and interesting exhibits.

If it be true that the buildings are to be destroyed and the exhibits so soon to be dispersed, pray tell me what is to be the recollection of this great Exposition? How long will it dwell in the chambers of your memory? Surely, if you have seen but 5 or 10 per cent, or even 20 per cent of the exhibits here gathered, what idea of the entire exhibition will abide with you? But in the ordering of events you will pass away, and then what remembrance will be left to the next generation? The permanent history of an exhibition is written through the third great feature of its existence, that of the awards which are rendered. The reports which are made, based upon the examination of its exhibits, form its most enduring monument.

(*a*) *Organization of awards bureau.*—The World's Columbian Commission appointed a committee on awards at its November meeting, 1892, and this committee, to facilitate work, formed an executive committee. This executive committee fortunately was composed of some of the brightest men of the Commission, and Hon. John Boyd Thacher, of Albany, N. Y., a man of great attainments in art and literature, and possessed of much executive ability, was chosen chairman. Mr. Thacher proved to be a man of remarkable perseverance, of great tenacity of purpose, and being a man of independent fortune, he gave his time exclusively to the trying and difficult position he occupied, with fidelity, persistency, and honesty. After the most careful investigation of the working of the different systems of award, after hearing experts, and after studying the act of Congress which created the Exposition, the awards committee determined that the awards should include a report giving the specific points of excellence presented by each exhibit, and that there might be a responsible personality connected with each award, that one man, a competent expert in each department, should make the preliminary examination of each of the exhibits, and that the award should be issued over the signature of that expert. It was further provided that the report of the expert should be approved and confirmed by the majority of the departmental committee, a committee made up of all the judges of the department. More than a year before the opening of the Exposition the chairman of the committee on awards wrote 2,600 different journals and technical periodicals, asking them to recommend experts in their special lines. By this means, and by the recommendation and

approval of the heads of the great educational departments of the country, and the recommendations of well-known experts, a critical corps of expert judges was selected for the different departments.

(*b*) *General plan of awards on implements.*—In a general plan of examination and report on machinery and apparatus for production, issued by the chairman of the executive committee on awards for the guidance of the judges, is set forth the purpose of the examination, and that it is desirable to ascertain the merits of the exhibits in (*a*) design; (*b*) construction; (*c*) operation; (*d*) efficiency of performance. "The plan upon which the exhibit is constructed and the proportion of its parts, the materials," their quality, the workmanship, and the correct distribution of material, the report said, could be most "conveniently determined on the floor where exhibited." The other two points "can sometimes be determined by placing it under the usual and proper conditions of regular working and exactly measuring the power exerted or cost of operation. In many cases, however, this can not be done upon the floor, as, for example, in the case of agricultural implements." At the end of the next paragraph it is remarked that "the last two points are much more important than the first two. It is what the apparatus can do that is most essential to ascertain." The instructions conclude with the following: "Reports will have real value only when made on all four points. Judges will make full reports in every case in which they do not find this completeness absolutely impractical, and the committee should endeavor to base upon their reports awards which will have real and permanent value to every exhibitor of a thoroughly meritorious article."

(*c*) *Field trials of field machines a necessity.*—As foreshadowed in the foregoing instructions, agricultural implements were necessarily operated in the field. On May 19, 1893, at a meeting of the manufacturers of agricultural implements, the chairman of the committee on awards stated that if a field trial could be obtained at no cost to the committee there would be field trials.

Mr. M. W. Dunham, of Wayne, Ill., tendered his great farm to the committee on awards, free of charge. The location of this farm, only 30 miles from Chicago, with its complete equipment of teams and steam power for the operation of the machines, and all other accessories in the way of diversified soil and different crops upon which to test the machines, made this offer of Oaklawn Farm acceptable to the committee, and field trials were, therefore, determined upon.

(*d*) *Time of field trials.*—Telegraphic invitations were sent by Mr. Thacher, on the 6th day of July, 1893, to all the manufacturers of the United States, notifying them of the trials, and urging upon them the desirability of producing machines for the trials. The dates named in the notices were as follows: For seeders and drills, August 15; for hay presses, September 15; for harvesters and binders, July

17-23, rye and barley; oats, July 31; for corn planters, August 8; for haying tools, July 17; for thrashers, July 25, rye and barley, and August 8 for oats; miscellaneous, August 8 (this included potato planters, fertilizers, etc.).

(*e*) *Rules governing field trials.*—The judges appointed to report upon the field trials of exhibited agricultural implements issued the following general rules on July 12, 1893, as their purpose and method:

1. All exhibitors proposing to submit their machines to the examination of the judges will be present at the date and place assigned, with machines fairly representing their regular make, in good order and ready for instant action. Horses will be provided, but the exhibitors will be expected to bring their machines on the ground and take them away after the trial, and to provide their own driver.

2. The judges will take their own ways of satisfying themselves of the merits of each machine.

3. Awards will be based upon the results of these trials so far as practicable; but the judges may report upon machines untested (or upon machines tested) upon such information as they may be able to collect from whatever source or in whatever matter found by them desirable and practicable. They will be governed in this manner by such principles and rules as they may find in their judgment most likely to result fairly and fruitfully.

ROBT. H. THURSTON.
HIRAM C. WHEELER.
CALVIN YOUNG.

(*f*) *Revolt against field trials.*—It was at this time that some exhibitors in group 16 determined that they would not take their machines into the field, and that they would have them examined on the floor, and that the "efficiency and performance" upon which the chairman on awards had laid so much stress should not be demonstrated by field trials. These exhibitors proceeded to combine and organize and present resolutions without regard to the scheme of awards which had been proposed or to the plan of procedure under which the committee on awards was working. In response to the pressing invitation of the chairman of the committee on awards to produce machines for the field trials, when the time came, however, less than half the exhibitors had machines at the Dunham farm. It was noticeable that the leading manufacturers of each line accepted the opportunity of putting their machines into the field. A description of the operation of these machines will be found hereafter, and a synopsis of the course pursued by those opposing the committee on awards will now be given. After bringing all possible influence to bear upon the committee on awards to induce the chairman of the committee to examine the exhibits on the floor of the annex, and after having failed, these exhibitors appealed to the committee of the national commission on exhibitors' grievances, setting forth as their ground of appeal—

1. The impossibility of complying with the order to go into the field trials.

2. The impracticability of the system adopted for the field trials.

3. The effect upon the history of the World's Columbian Exposition as made up through the bureau of awards if the rule requiring field trials was allowed to stand.

4. The damage that would result to the American manufacturers if their exhibits were not examined.

5. The discrimination against the American exhibitors in favor of the foreign exhibitors of like machines in the same class, and the granting to one set of American exhibitors concessions not given to others under like circumstances.

These different grounds were urged before the committee at great length. It was asserted in the argument that exhibitors had not sufficient time from July 6, on which day the notice of field trials was given, to prepare harvesting machines and get them into the field on July 17. It was also urged that the manufacturers would have to prepare duplicates of their machines for field trials, and that this would be impracticable. The exhibitors urged that they had been requested to finish their machines in the highest state of the art, and that they could therefore not afford to submit other machines for field trials. These objecting manufacturers also urged that the kind of soil, the contour of surface, and the condition and varieties of crops that the machines had to contend with in this and foreign countries do not exist on any one farm. Rumors that reached the chairman of the executive committee on awards caused him on August 8 to again advise Mr. Buchanan, chief of the department of agriculture, that "Under no circumstances will any machine exhibited by American manufacturers, for the examination of which machine arrangements had been properly made for the field trials, be examined or reported on by the judges unless such machines go to the field." The confinement of this order to American manufacturers was due to the fact that foreign exhibitors had in almost all instances made no arrangements to exhibit their machines in the field. The exhibitors urged with great force that if Chairman Thacher insisted upon this ruling the history of the Exposition would show but few machines to have been present rather than many, and that this would be unfair to an industry in which this country excels all others and in which more than $280,000,000 are annually engaged, and (exhibitors went on to say) "an industry that has done and is doing a grand work in civilizing and elevating the downtrodden of all nations."

The chairman of the committee on awards replied that "the point of view taken by the exhibitors was entirely wrong," the real question being what the committee on awards and the expert judges appointed by them deemed necessary to intelligent judgment, rating, and awarding. "It is not what exhibitors desire or deem sufficient, and in case of such difference of opinion the decision of the judges and the committee on awards should be taken as final." The chairman stated further that the committee on awards had considered the matter care-

fully, and had come to the conclusion that trials in the field were perfectly practicable, and were of great value in determining the real merit of such machinery; that certain exhibitors had attended the trials not only cheerfully, but had shown the greatest desire to secure the most complete possible exposition of the merits of their respective machines in actual work. Referring to the second point the chairman said that actual trials had proved the system adopted to be thoroughly practicable, and that the committee on awards and judges accept the results of these trials as a basis on which to found thoroughly satisfactory decisions. In relation to the third point Mr. Thacher said that sufficient material had already been collected—largely through the field trials that had already been held—to serve as material for a history of the development and present condition of this department of manufactures, and that the field trials already held have at least secured facts in place of mere opinions. "So far as such history shall prove incomplete," he said, "the exhibitors themselves and not the authorities of the Exposition are responsible." He answered point four by saying the damage resulting to American manufacturers was from their own choice. Referring to point five, in relation to the advantage that the foreign exhibitor had over the American exhibitor, he called attention to the fact that the diplomas of the foreign exhibitors could only rest upon the "design and construction" of their machines, and that so far as any discrimination taking place was concerned it was in favor of the American manufacturer, as his diploma would be far more valuable than that awarded the foreign exhibitor, because of its being based on the essentials of the machine, viz, "the operation in the field and the efficiency of the performance." The following is quoted from the same statement that was made by Mr. Thacher to the committee on special grievances:

> The judges will testify that it is only by witnessing the actual working of the machine in the field that an intelligent and trustworthy judgment can be formed, and that while this involves much trouble to the judges as well as the exhibitors, and some expense, they considered it the only practicable and satisfactory method. The end fully justifies the means.

As a final statement the chairman said that the action of the committee on awards should stand, in justice to those "who gladly complied, by taking their machines to the field, with every regulation, without cavil, and took all the trouble and met every expense involved cheerfully, and thus gave the judges all the needed facts on which to base an intelligent and correct report of their exhibits." The special committee reported on September 6, recommending that the American machines be given a floor examination, but the national commission refused to adopt the report of the committee, thus sustaining Mr. Thacher in his position, a position that was not only right logically but practically.

Not satisfied with the refusal of the World's Columbian Commission, the rebellious manufacturers of agricultural implements determined to try again. And after getting their case printed they succeeded in having a special committee of four appointed on the 15th of September, which committee was, under the resolution creating it, to "have full power to send for persons and papers and to determine the scope of inquiry and make reports to the executive committee, with right to print such reports and so much of the evidence as in their judgment may be necessary, and that the report of the special committee on grievances be referred to this committee for consideration." This committee met on September 22, and the rebellious implement manufacturers were represented by two attorneys. These attorneys called witnesses, submitted affidavits, and had every facility shown them to thoroughly investigate the subject. In the opening of their case they stated the grounds of their contention to be "first, no field trials; second, the excusing of the foreigners and the short notice." The proceedings before this committee occupied several days, and when published made a volume of 264 pages. The honorable commissioners who sat in the case sought to get at the merit of the controversy, and allowed so wide a margin to the inquiry that no facts bearing upon the case were refused. On the first point, that there were to be no field trials, the chief of the department of agriculture was called as the first witness, and there was an endeavor made to show by him that as the exhibits were installed, and thereafter he had led exhibitors to believe that there would be no field trials. He, however, testified that "the entire work of forming the system of awards and determining the rules under which those awards were to be made was to be decided by the national commission; that this commission, through the chairman of committee of awards, Mr. Thacher, had formulated a plan which had been approved by the commission, and that the exhibitors could mark it down as a settled fact that these rules of the chairman of the committee on awards was the law and gospel of the Exposition." He stated his understanding to be that if the exhibitors did not want awards they had the power to prevent their exhibits being examined; but if they wanted awards they must conform to the regulations of the committee on awards. The depositions of several of the objecting manufacturers and their employees were taken, tending to show that they entered their goods with the idea that there would be no field trials, and that when it was determined that there were to be field trials the time allotted to get their trial machines to the field was too short. Mr. Thacher was called as a witness by the exhibitors, and after answering a number of questions asked him by the attorney of the exhibitors who were seeking to have their machines given a floor examination, was requested by the committee to make a statement outlining the position of the committee on awards, which he proceeded to do.

Commissioner Butt, of West Virginia, was chairman of this special committee, and stated to Mr. Thacher that the controversy related, first, to the jurisdiction and right of the committee on awards to make the rules and regulations which have been made and promulgated in reference to field trials; second, as to whether or not he gave these people a sufficient and proper opportunity to get their machines to the place where they had to bring them within the dates named by him in his order.

On the question of jurisdiction and right, Mr. Thatcher stated, "the act of Congress authorized, in section 6 of the act approved April 25, 1890, the World's Columbian Commission to appoint all judges and examiners and to make awards. The World's Columbian Commission by a formal by-law created a standing committee called the "committee on awards" and gave that committee charge of the subject of awards. The committee on awards appointed an executive committee on awards, of which Mr. John Boyd Thacher was chairman, which committee had all the powers, rights, and privileges of the committee on awards. This executive committee was formed for the purpose of facilitating administrative work, and was created at the suggestion of the World's Columbian Exposition, through its board of control. The executive committee on awards adopted rules and regulations governing awards, which rules and regulations were approved by the full committee on awards, and adopted by the board of control January 14, 1893, and promulgated through the director-general January 16, 1893.

Continuing, Mr. Thacher said:

There are two important features of the rules and regulations to which attention should be called.

1. The individual judges are to perform such duties as the executive committee shall prescribe.

2. Any exhibitor may have his exhibit exempted from examination for awards by notifying the executive committee; otherwise the executive committee has the right in its discretion to call any exhibit to be examined.

It is plain that the foregoing conclusively disposed of the objection that the executive committee on awards had no authority to order field trials.

The act of Congress approved April 25, 1890, declared that the four hundredth anniversary of the discovery of America should be commemorated by an exhibition of the resources of the United States and the development and the progress of civilization in the New World. This was interpreted by the committee on awards to mean that the examination of exhibits and the pronouncing of judgment thereon should be conducted along lines which would best disclose to the world the progress made in the arts, industries, and sciences.

Governed by such purposes, the executive committee on awards, after mature deliberation, decided that field trials should be made of agricultural implements in order to disclose to the world the progress made in that important industry and to furnish the great farming interests of America and of the world reliable information as to the development and condition of this industry. The executive committee on awards

consulted with experts and decided that, while the larger percentage of the agricultural implements could be examined on the floor, still a certain percentage of these implements required a practical examination by actual operation in the field.

Mr. Thacher submitted the copy of the following letter to show the opinion of the judges as to the necessity of field trials:

I have to say in brief that this committee has been convinced by the experience in connection with this exhibition, as well as by their earlier knowledge and more extended experience with this class of machinery in particular, that it would be quite impracticable to obtain that knowledge of the real working value of machinery except by observation of its actual performance in doing its legitimate work under conditions to which it is especially adapted in the field.

Very respectfully,

R. H. THURSTON, *Chairman.*

We fully concur in the above.

CALVIN YOUNG,
HIRAM C. WHEELER,
Members.

On the question of whether or not sufficient time was allowed to get machines to the field, Mr. Thacher called the attention of the committee to the fact that he addressed a meeting of the agricultural-implement manufacturers on May 19, sixty days before any trial took place, and stated that "if a field could be obtained at no cost to the committee there would be field trials." On June 30, at another meeting of the agricultural-implement exhibitors, Chief Buchanan read a letter from Mr. Thacher, written in his official capacity as chairman of the committee on awards, that contained the following:

We believe it is desirable and profitable to have a field trial of almost every entry of exhibits of agricultural implements. * * * The bureau request to be examined all agricultural exhibits entered for awards if a field or fields can be obtained which will offer conditions favorable to the trial of various classes of exhibits.

The committee on awards was during all this time searching for fields and facilities and looking for some public-spirited agriculturist who would open his fields and furnish teams without charge, as the committee on awards had no money for such expenses. About the 1st of July, as heretofore stated, M. W. Dunham tendered Oaklawn Farm, with its 1,700 acres of diversified soil and crops and all its superb facilities, free of expense to the committe on awards.

In order that no time should be lost, telegrams were immediately sent to the different exhibitors. These notices were sent on the 6th day of July, and the first trials, those of haying tools, were to take place on the 17th, thus giving eleven days' notice. A letter addressed to the freight agents of the different railroads that would naturally carry the freight from the factories of the different manufacturers of haying tools to the Dunham farm at Wayne was submitted to the committee, and the average time required for shipment by freight was three and one-half days, and the longest time required for any exhib-

itor was eight days. The time for the trials of seeders and grain drills was forty days, and the longest time, as shown by the letters of the freight agents, that it required to get machines to Wayne, was five days. For hay presses there was seventy days' time, and the longest time required for shipment was six days. For thrashers there were nineteen days, and the longest time required for shipment was eleven days, while for harvesters and binders there was seventeen and one-half days, and the longest time required was seven and one-half days. When it is taken into consideration that most of the exhibitors had branch houses in the city of Chicago, it is readily seen that the claim of the exhibitors that there was not sufficient time for them to get machines to the field was not well grounded.

Mr. Thacher further submitted to the committee letters from the different exhibitors who had taken their machines to the field, which letters called the attention of the committee to the fact that these exhibitors acquiesced in the rule of the committee on awards, and had submitted their machines to the judges in the field, and that it would be manifestly unfair to them if the exhibitors who have so rebelled against and so hampered the committee should now be allowed to have examinations for awards without submitting to the same rigorous tests in the field. These letters were from the following firms: Stoddard Manufacturing Company, Dayton, Ohio; Dederick & Co., Albany, N. Y.; Sterling Manufacturing Company, Sterling, Ill.; and the Geiser Manufacturing Company.

The letter of the Sandwich Manufacturing Company to Mr. Thacher is a strong justification of the course of the committee on awards in ordering field trials. This letter was written on July 8, and says in part:

> It would appear that nothing included in our exhibit, except our harvesting machine, would be eligible to a place in the proposed field contest. Of that machine we have to say that it is so entirely new to our manufacture that we hesitated somewhat to put it into a contest with the older and more thoroughly tested machines coming from the factories of the standard harvester manufacturers of the country. Its various distinctive features we are thoroughly satisfied with, and fully believe in the superiority of some of them, but have only this season embodied them in the form in which we propose to put them before the public, if they bear up well under the wide range of tests to which we propose to subject the limited number we shall build this year for that purpose.

It is submitted that no expert upon this class of machines could have examined the Sandwich binder upon the floor of the Exposition, and, from the design and construction of the device, could have told whether the machine would or would not have successfully operated in the field.

Inasmuch as some of the witnesses introduced by the rebellious exhibitors had sworn that all manufacturers prepared special machines for use in field trials, fitting such machines with bearings of brass and

machine-cut gearing, and otherwise changing parts of the machine so that they would operate more perfectly, the exhibitors who had taken their machines into the field trials at Wayne testified before the committee that the machines they had taken to the field were machines of regular manufacture, such as are built and sold regularly to the trade, and that they were not changed in any particular; that they were only carefully examined to see that all the bearings were loose and ran freely. The exhibitors who took their machines to Wayne also produced before the committee two noted experts in machinery, Mr. James W. See, of Hamilton, Ohio, and Mr. William Worth Burson, of Chicago. These men testified to their long familiarity with machinery, and especially with agricultural machinery. As disinterested experts, they testified to the absolute necessity of field trials to demonstrate whether a tool could be successful in operation. Mr. Burson, who is an inventor of agricultural appliances, and who built in 1864 the first thousand grain binders that were ever sold, testified that with all his experience, extending through a lifetime of close study of farm tools, he could not tell by mere examination whether the knotting device of a self-binding harvester would successfully tie knots when put to work in the field under the varying conditions there encountered.

The special committee on complaints, after considering the testimony and exhibits, decided that sufficient cause had not been shown to justify the committee in changing the regulations of the executive committee on awards; and that in the opinion of the special committee the rules and regulations of the executive committee on awards were reasonable and should have been followed by the exhibitors. Some of the exhibitors became discouraged and gave up the fight after this decision, and by gathering all possible influence succeeded in getting the chairman of the committee on awards to appoint jurors to go to remote places in different parts of the country, even to the works of some of these exhibitors, and there examine their implements at work. The newspapers called these trials at the time "backyard trials." One of the exhibitors, who complained about the expense that was entailed by a trip to Wayne, 30 miles from Chicago, afterwards took the jurors 1,400 miles from Chicago to see his machine at work. The expense of such trips show plainer than words can picture how these exhibitors dreaded meeting their competitors at the official trials, and the value that they placed on an award of the World's Columbian Exposition. The expert judges. who had followed the machines through the regular appointed field trials, declined to follow machines into "backyard" and to remote places and resigned their positions. The refusal of these companies to enter the regularly appointed field trials at Wayne and there test their machines in the same field and on the same crop with those machines that did go to Wayne—when they were so anxious for awards that they sought

secret special trials, and at distances so remote as to be beyond the reach of other manufacturers building similar machines—can only be explained on the hypothesis that they realized that their machines were inferior. The Dederick hay press was put to work in baling the coarse, stiff heavy growth of timothy and blue grass on the Dunham farm, while its competitors, the Whitman, Famous, and Quincy presses, were tested at "backyard trials" on hay of far different quality. The McCormick mowers and self-binding harvesters were tested in the heavy grass and grain of the Dunham farm and drawn over the soft loam of its fertile fields; while the Deering mowers and binders were taken during the month of October into the high valleys of Colorado, nearly 400 miles southwest of Denver, and there tested in a light crop of easy cutting alfalfa and in a field of grain of light growth and stiff stalk that grew in a valley as level as a floor and on soil as compact and hard as many roadbeds. It is self-evident that the conditions were as unlike as possible, and that there must have been very strong grounds, to say the least, that would cause the Dederick hay press and the McCormick harvesting machines to be the only ones in their respective classes shown in operation at Wayne, in response to the urgent invitation of the chairman of the committee on awards.

The rebellious agricultural exhibitors that did not submit to the original order for field trials on the Dunham farm, and that had not taken advantage of the "backyard" trials, still maintained that they must be accorded a floor examination, and their next move was to send copies of their protesting documents to the director-general of the Exposition, George R. Davis. They, acting through the chief of the department of agriculture and the director-general, whose duties had nothing to do with the subject of awards, transmitted the entire matter to the president of the World's Columbian Commission. Presumably without having examined into the position of the chairman of the committee on awards, without having taken the trouble to read the report of the special committee that went thoroughly into the merits of the case, the director-general urged upon the commission immediate action granting floor examinations. The director-general appeared not to have considered that the commission had decided that these floor examinations should not be made, and that it would be necessary that the commission should reconsider its action before the exhibits could be examined on the floor. The national commission received the protest, together with a letter from the chief of the department of agriculture, and one from the chairman of the committee representing the rebellious exhibitors, and the documents were laid upon the table until the same subject should come before the commission in a communication from Mr. Thacher of the executive committee on awards.

The communication from Mr. Thacher followed in a few days, and was to the effect that in view of the fact that the national commission had sustained the committee on awards and thus indorsed and approved the action of the committee on awards in prescribing field tests, Mr. Thacher was now willing, with the approval of the commission and with the understanding that any diploma granted should state distinctly that the examinations of the exhibits were made upon the floor and not as the result of a field-trial test, to appoint judges and have these exhibits examined on the floor. The national commission was thus besieged by communications from the director-general, from the chief of the department of agriculture, and from the rebellious exhibitors. The most powerful influences possible had been brought to bear to induce Mr. Thacher to grant the floor examinations, and these influences were finally sufficient to cause him to offer the floor examination, with the understanding that the diplomas should specify that they were granted on floor examinations solely. A resolution was offered in the commission to adopt the suggestion of the chairman of the committee on awards, but it did not prevail, and though the matter was several times afterwards brought before the commission it could not be carried. The time for closing the Exposition had now arrived, and after examining all possible plans for obtaining a floor examination, the rebellious exhibitors prepared descriptions of their machines, and sought to have these descriptions examined and have awards granted based upon these descriptions. Failing in this, their final move was to have a resolution introduced into the Senate of the United States the purport of which was that the Committee on the World's Columbian Exposition in Congress should be instructed to investigate the matter. Nothing has been done with this resolution, and it is undoubtedly but one of the many thousands of such resolutions yearly introduced and never heard of again. An ending to all things, these exhibitors finally reached the end.

(*g*) *Appeal of Canadian exhibitors.*—While these rebellious United States exhibitors of agricultural machinery were so tenaciously seeking to have their own way and to obtain awards, under conditions prescribed by themselves, a firm of Canadian exhibitors, manufacturers of implements of various kinds, but still of the same type as those that had been ordered into the field trials, considered that they were aggrieved, and J. S. Larke, executive commissioner of Canada, appealed to the national commission, addressing Hon. Thomas W. Palmer, its president, on November 3, 1893, and asked for a reexamination of the exhibits of the following Canadian exhibitors: Massey-Harris Company, Sawyer-Massey Company, John Abell Engine Works, Van Tuyl & Kleinsteiver, Cockshutt Plow Company, John Grout, Manson Campbell. The grounds alleged were that there was omission of an examination of a portion of these exhibits; second, an incorrect state-

ment of facts on which the returns of jurors were based; third, irregularities in the submitting of the cards by the jurors; and, fourth, that the action of the juror Mr. Praether was contrary to the regulations governing awards, as promulgated by the director-general, and contrary to justice. This communication was referred to a committee of the commission, who reported on November 14 that the communication was one that should by right be heard by the court of appeals on awards. Mr. Larke then brought his charges before this court, which convened in Washington, D. C., on the 8th day of January, 1894. Mr. Larke appeared for the complainants, and Hon. Thomas L. Williams as the representative of the committee on awards. Record and oral testimony was submitted and arguments thereon were made by the counsel. The facts in the case showed that there was an examination of the exhibits referred to, but that a reexamination of the same was ordered by the executive committee on awards. This reexamination reported adversely to awards being granted. A short time after this reexamination, and finding that no award should be granted, on the grounds that the exhibits were "copies of American machines," * * * "therefore not entitled to awards," a second reexamination was ordered, the judge being Mr. Charles Whitney, an inventor of agricultural implements. Mr. Whitney also found that the Canadian machines were copies of machines made by United States exhibitors and they were therefore not entitled to awards. The decision of the court of appeals was to the effect "that the proofs failed to sustain the allegation set forth in the complaint and the complaint was ordered dismissed.

It should be stated that the self-binding harvester, reaper, drill, broad-cast seeder, and rakes of the Massey-Harris Company, of Toronto; the traction engine and separator of the Sawyer-Massey Company, of Hamilton; the separator of the John Abell Engine and Machine Company, of Toronto, and the thresher of Van Tuyl & Kleinsteiver, of Petrolia, Canada, were the only Canadian exhibits that were subjected to a reexamination. No attempt was made to show that these machines were not United States inventions, and copies of United States machines. The view taken by the honorable commissioner of Canada was: "That awards were not given on invention, but on the fact of the excellence and advancement of the machine, without regard to where the invention was perfected." This as an abstract proposition is perhaps true. It can not be presumed, however, that the judges had no other reasons than those stated above; in fact, in certain instances the judges reported the device as "not worthy of an award." In another instance, that of the Massey-Harris wide-open binder, the original judges, none of whom were experts in self-binding harvesting machines, reported that the exhibit had the following points of excellence: (1) the open end; (2) the floating upper

canvas belt; (3) ease of operation; (4) elevator roller that carries the grain to the binder deck; (5) bearings that are interchangeable and insure perfect alignment; (6) good arrangement of the binding attachment and long shift; (7) the arrangement of the knotter, especially the open cord-holding ring and cutting apparatus; (8) the grain guard in front of platform belt guide; (9) front platform belt guide; (10) the divider with subdivider; (11) the easy appliance of the transport truck. (Signed) D. E. Geisler, judge.

Mr. Geisler was a German professor that knew something of agricultural implements as used in foreign countries. He, however, had no critical knowledge of that distinctively United States implement—the self-binding harvester. The first reexamination of this implement was made by myself, with another judge of the department, and we reported against an award. The second reexamination was made by Mr. Charles Whitney, an inventor and manufacturer of self-binding harvesters, and in his testimony before the special committee he said:

> I recollect this card well for the reason that the points of merit mentioned upon which an award was granted are so commonly in use in this country as to be called old, not a novel feature being in it, and I indorsed it, "No award."

Canada being considered a foreign country, its agricultural implements were not called into the field by the chairman of the committee on awards to participate in the field trials. This was manifestly of advantage to the Canadian exhibitors, inasmuch as it would have been easier for the Canadian builders of agricultural machines to have got their machines to the field trials at Wayne than it was for many of the United States exhibitors to get their machines there. The exhibitors who objected to going into the field trials gave the fact of the exemption of the Canadian machines as one of the reasons why they should not be compelled to exhibit their machines in the field. How manifestly unfair, then, it would have been to have granted awards to those Canadian machines that did not show in design and construction as favorable an arrangement of devices as were shown by similar types of machines in the United States exhibits. Had these machines gone into the field and demonstrated by actual operation a high efficiency, Commissioner Larke might then have had a just complaint against the committee on awards. The Canadian protesters, however, did not offer to demonstrate the availability of their machines in actual work, and being copies of devices which were found in more symmetrical shape in United States machines, and constructed in a more thorough and workmanlike manner, the justice of the findings of the judges and the refusal of the committee on awards to honor the Canadian machines can not be questioned.

VIII. GROWTH OF INVENTION IN UNITED STATES.

Standing on the colonnade that connected the machinery hall and agricultural buildings and looking north over the most magnificent sight the eye of man had ever beheld, an inscription on the base of the obelisk would bring the mind of the traveler to contemplate the causes that had created so beautiful a scene. The inscription was:

> Four hundred years after the discovery of this continent by Christopher Columbus the nations of the world unite on this spot to compare in friendly emulation their achievements in art, science, manufactures, and agriculture.

In manufactures and agriculture it did not require "the nations of the earth" to meet in order to fill the immense buildings that stretched away to the east and to the west of the obelisk with the exhibits which they contained. It was American manufacturers and American agriculturists that created these exhibits. This is only another way of expressing the thought that it is our own country that is peculiarly the pride of this century, and our country and this century, when compared with other countries and other centuries, appear rather as a contrast than as a development. It is not easy to state their relation to the past in terms of progression, since they may be said to have leaped into existence, and any description is one of new creations rather than evolutions of old. It is the majestic works of the present that excite our admiration.

Up to the time of the Revolutionary war the colonists had done but little, if anything, in the way of manufacturing. The laws of England had rigorously forbidden all important works in iron. Immediately, however, peace had made possible commercial and mechanical enterprise, a new era dawned. In the first fifteen years after the treaty of peace the first cotton mill was built in America, and Samuel Slater introduced the Arkwright system of mill spinning, and was obliged to make the carding, drawing, roving, and spinning mechanism from memory, as England successfully prevented the exportation of the machines. Even at this time the notion was prevalent in England that America "could only be the parent of degenerate and feeble races." Buffon had suggested and Raynol had confirmed this notion. They said no man of intellectual ability, no poet, philosopher, or statesman had yet appeared in the New World. Franklin, Washington, the two Adamses, Jefferson, and other historic names rose up before mankind almost while they spoke. In 1775 Oliver Evans had introduced his improvement in grain mills, and a few years afterwards his steam engine, the first double-action, high-pressure steam engine on record. In 1785 Rumsey, and in 1788 Fitch, had their boats on the Potomac and Delaware, respectively. In 1787 Jacob Perkins had his nail-cutting machines and dies for coin. In 1794 Whitney's cotton gin, and in 1797 Whittimore's card-sticking machine, came to the help of

the cotton interests. Other inventions followed in rapid succession. In the meantime the continental philosophers and statesmen, princes and poets, had been watching with singular attention the revolt of the New World against the traditions of the Old. The rising fame of Washington, the ability and force of Hamilton, the sturdiness of Adams, with the marked industrial and mechanical progress that quickly followed the Revolution, led the thoughtful to consider whether they had not been mistaken in thinking "a degenerate and feeble race" was to be the outcome of the mixed peoples that had emigrated to America.

(*a*) *Invention follows profitable lines.*—It is impossible to examine in detail all the various machines that were in the agricultural implement annex. It is therefore necessary, since a rapid preliminary survey of the implements of agriculture down to the beginning of the present century is contained in the beginning of this report, that the remaining space be devoted to a few prominent implements, the invention and development of which have been the work of Americans. It has been said that the peculiar conditions surrounding a people bring forth distinct varieties of tools and methods. To a certain extent this is undoubtedly true; still, it would not apply at all outside of the English-speaking nations, as the mechanical progress of the world is found within these limits. Neither would it apply to certain localities even in America, nor particularly to certain races—for instance, Rhode Island has an invention to every 825 inhabitants, and Connecticut one to every 700; while South Carolina has but one to every 21,000, and Mississippi one to every 22,000. Nevertheless, among ingenious people invention follows these lines where the appliances are necessary and where there is opportunity for their profitable employment. On this ground can be explained the American inventions in agricultural implements.

IX. INVENTION AND EVOLUTION OF THE PLOW.

For thirty centuries there had been but slight changes in the plow. The pictures on the palaces of Thebes resemble the plows used even to this day in the greater part of the world. Even in the colonial days of America the plow was wood, except, perhaps, a wrought-iron share. The wooden moldboard was sometimes plated with sheet iron. It was not, however, until 1819, when the agriculturists along the coast had longing eyes on the agricultural lands of western New York and the Shenandoah Valley that Jethrow Wood, of Cayuga County, N. Y., made his improvements in plows, the peculiar merit of which consisted in the mode of securing the cast-iron portions together. He did more than any other person to drive out of use the cumbrous plows common throughout the country. His was the first plow in which the parts most exposed to wear could be renewed in the field by the substitution of cast pieces. Since then improvement in plows has been

largely in determining the proper shape of the moldboard to do the work and offer the least resistance. After the shape of the moldboard had been settled for the coast users by practical experiment in the field, the plowman that had brought his cast plow or his wooden one strapped with iron across the Alleghenies was confronted with the fact that it would not turn over the turf of the Western prairies, and ingenuity was necessary to devise the long steel moldboard with easy curve and pointed share and cutting knife of hardest steel. After the strip of turf had been cut it could be rolled over by rods that were given the right curve to act as moldboards. When, however, it came to replowing these prairie soils of black, sticky loam the plows would not scour and it was found a very difficult job to fasten hardened steel plates that would scour into the form of moldboards. It is told of John Deere, the pioneer plow builder, and founder of the great plow business and company, at Moline, Ill., and whose successors in business were awarded diplomas for single, sulky, and gang plows, that in 1837 he made the moldboards of his first plows of old saws in order to make them scour. It was very hard to bend and uniformly temper the steel plates, and plates with a center of soft iron were introduced. The soft center was found to prevent warping and to remedy the defects of a lack of uniform tempering of the steel moldboards that had heretofore troubled the plow makers.

John Lane obtained a patent September 15, 1868, for a plate of three layers, the outside ones of steel and the center of soft iron. The specification lays stress on the layers of steel on the outside balancing each other in heating and tempering, and upon the strength given to the plate by the soft center. William Morrison, however, patented a plate of two layers, one of steel and the other of soft iron, in 1864. It is hardly as satisfactory as the three-layer plate, still it is used by manufacturers at the present time, and is perhaps more durable. Plows made of these plates of steel and iron turn the broad acres of the West and Northwest with a lighter draft and with a more perfect pulverizing of the soil and turning under of the top layer with less trouble and with greater ease to the operator than plows have ever before been operated in any land. Mr. Marsh, a pioneer inventor and manufacturer, once wrote:

> What a contrast between our plow and the thing so called in Russia, for instance; and what a contrast, also, between the respective operators. Like plow, like man. On the one side a brightness, keenness, and adaptability; on the other, a coarseness, clumsiness, and stolidity. Americans whittle because they carry finely finished and keen cutting knives, and it is a pleasure to use them. The same pleasure exists in the use of our machinery generally. Not so in Europe. Their implements excite no impulse to operate them nor pleasure in their operation. If your knife was but a piece of wrought iron edged, you would have no impulse to whittle. A European peasant's plow beside one of ours affords a like comparison. It does seem as if the general diffusion of intelligence throughout the world by paper, steel, and electricity

would ere long awaken the foreign tiller of the soil and penetrate the stolid soul with an ambition for better things than what have come down to him scarcely improved for a thousand years, and he ought to begin the new life with the American plow.

Sulky and gang plows have been developed to meet the conditions arising from the large farms of our Western prairies. It is only a few years ago, hardly thirty, since the first riding sulky plows were used. They were a development from the wheeled plows that had been used for centuries. The Scotchman put his pair of wheels under the forward end of the beam and steadied his plow with a pair of long handles. The sulky plow of to-day only has the wheels set back over the plow, the handles have been taken off, the driver gets on to the wheels, and the plow, being attached to the frame of the wheels by swinging connections, is lowered into the ground by a lever and raised from it by the same means. The first developments were in the way of smaller plows used in gangs, but within the past ten years the 16-inch plow on two or three wheeled frames have largely taken the place of the gang, except in certain sections of the country. The Davenport gang was the first one that the writer has any recollection of that was at all practicable. This was in 1864 or 1865. It was not until ten years after this that Gilpin Moore got his patent on the famous Gilpin plow so long made by Deere & Co. About the same time the Oliver Chilled Plow Works, at South Bend, Ind., brought out the Cassady sulky, which had one of the wheels set at an angle against the furrow to support the plow and thus do away with the landslide. This company had a large exhibit of chilled plows, walking and riding plows, in the implement annex, upon which they obtained several awards.

American inventors and mechanics have attached the gang of plows immediately to the steam traction engine and have thus made a success of steam plowing. Cumbersome methods, using windlass and cables, have been tried abroad, but American farmers would not bother with such unhandy contrivances.

Plows were not included in the order for field trials. It is therefore impossible to enter particularly into the principles and devices that were shown. The plow makers did their part toward making the implement annex attractive. Four of the exhibitors in the German section showed plows, and two of the Canadian exhibitors received awards on plows, as did two of the Russians.

X. INVENTION AND EVOLUTION OF THE HARROW.

The harrow is another implement of antiquity, and while it has been improved in form, made lighter and more easily handled, its teeth made adjustable, still, as a means of pulverizing the soil, the Roman spiked-toothed harrow, the disk harrow, the toothed roller, the cultivators, and scarifiers have been known and used for more than a half century. These implements stir the soil without reversing the

surface. Loudon's Encyclopedia of Agriculture, 1835, shows various forms of improved cultivators mounted on wheels. Brakes, grubbers, and revolving disk harrows, as well as straight disks, which are described as "a roller composed of thirteen thin iron plates fastened to a block of wood," were all described by Loudon. The inventions of Americans in these lines appear to have been in placing disks in a gang and in placing these gangs at an angle to each other. A large number of disk harrows were shown, as well as many peg-tooth harrows, horse hoes, and cultivators. It is hardly necessary to say that they were symmetrically proportioned machines of beautiful design and finish, and did credit to their makers. There were also many spring-tooth harrows shown, and these tools perhaps contained as much of invention over old forms as any of their class. The patent records show that D. L. Garver, of Hart, Mich., took out a patent for a spring-tooth harrow in 1869, but it was not a marked success until it was improved so that the teeth were attached to the bars by adjustable clips. Since then these harrows have come into extensive use. D. M. Osborne & Co., of Auburn, N. Y., David Bradley Manufacturing Company, Chicago, the Stoddard Manufacturing Company, and the Dayton Farm Implement Company, of Dayton, Ohio, and others, showed these harrows in various forms.

XI. INVENTION AND EVOLUTION OF SOWING MACHINES.

Sowing machines in the lines of broadcast sowers, drills, corn planters, and potato planters were exhibited in great variety. The improvements in these implements were largely in the ways of making the old forms more effective and certain in operation. From earliest time grain has been sown by seeders. The hand barrow with seeder mounted on it has been used for ages in China. The improvements that we have made in seeders are in perfecting the devices that select the requisite amount of seed from the hopper in which it is contained, and scattering it that it may be evenly distributed over the ground. In drills we have done something in improving the form of the hoes, in holding them to the ground, and in covering the drill furrow. Before Jethro Tull, in 1730, began his very valuable work in improving the grain drills, he had heard of seed sowers in use in Spain and Germany that regularly dropped the seed in the furrow behind the plow. The force-feed seeder and drill were in use a hundred years ago in England, at which time a cylinder with a series of cups revolved in the bottom of the grain box, and the seed was deposited in funnels, the lower ends of which led immediately to a furrow cut by knives that were connected to a beam so as to be kept in an even line and easily handled. Weights were placed upon the knives to keep them in the ground for the same reason that springs are placed upon them at this day.

(*a*) *The modern corn planter and check rower.*—The corn planter is but a drill with its grain boxes and knives separate, and the wide wheels which carry the frame on which the driver rides further perform the office of coverers to press the soil about the grain that has been deposited in the furrows cut by the knives in practically the same way and for the same reason as the rollers were drawn behind disks many years before. There is, however, this distinction between the corn planter and the drill, viz, the necessity of dropping the corn in rectangular arrangement or, as it is commonly called on the farm, "in check," by which means the corn can be cultivated both ways. George W. Brown, of Galesburg, is perhaps the first to attach to the cylinder or slide that carries the cup a lever by which the grain could be dropped into a furrow opened by a flaring knife. Behind this furrow he placed the covering rolls, which were but the wheels on the frame of the machine. In 1860 this patent was reissued to cover all the novel features of his machine, particularly the hinged joint between the tongue and the rear of the machine and the lever arrangement by which the driver could raise the shoe part of the machine from the ground. The marker, projecting from the side of the machine and sliding on the ground to make a mark that the driver can follow as he goes back across the field, was shortly introduced. The rotary feed plate, given a forward advance on each movement of the hand lever, the gearing of the feeding device to the axle, and the check rower, soon followed as improvements. The check rower was an ingenious invention. Martin Robbins, of Cincinnati, experimented in 1857 with a machine in which a vibrating arm with a claw was connected with a seeding mechanism having a reversible hopper, all to be combined with a jointed rod or chain on which were buttons, the chain to be anchored in the field and the machine to be driven along the chain. There have been many changes and improvements since that time. The Haworths, who purchased several early patents and reissued them and made improvements of their own, and who were exhibitors at the Exposition and received awards on their planters and check rowers, did much to make practical this ingenious device. The Keystone Manufacturing Company, of Sterling, Ill.; the Hayes Pump and Planter Company, of Galva, Ill.; the Deere & Mansur Company, of Moline, Ill.; the Fuller & Johnson Manufacturing Company, of Madison, Wis., and the Barlow Corn Planter Company, of Quincy, showed planters and operated them in the field. Deere & Co., of Moline, Ill., exhibited a corn lister. These exhibitors received awards and their machines, constructed almost entirely of steel tubing and malleable iron, were creditable examples of the taste and skill of American manufacturers.

XII. INVENTION AND EVOLUTION OF THE REAPER.

The reaping machine attracted but little attention until the year 1851, when at the World's Fair in London the American machines created much excitement and caused the forgotten experiments of half a century to be hunted up and exhibited in order to "cool the enthusiasm of those foreigners." On examining into the matter it was found that there had been experiments in building reaping machines in England, but that these experiments had for some reason ceased in the twenty years prior to the World's Fair of 1851. In examining those inventions to-day, it is seen that they were principally directed to revolving cutters or systems of revolving blades, to trying to produce an oscillating movement of a knife analagous with the swing of the scythe and the reach of the sickle, and finally to shears with long blades. Most of the inventors attached the horses behind the implement, which they pushed before them, though Gladstone, in 1806, hitched the team in front of his experimental machine. Ogle, in 1822, had a side draft and reciprocating knife, but had an impracticable way of moving the knife. He built but one machine and abandoned it after a short test. In 1828 Bell, a preacher, built a machine which was pushed ahead of the team and cut the grain with a series of shears with blades 16 inches long. An endless apron, on inclined rollers, was placed immediately behind the cutters and carried the grain to one side of the machine. It has been said that two or three of these machines were built.

(*a*) *Early failures.*—Looking back at the early English experiments, carefully studying the descriptions of them in the publications of their day, and with a knowledge of the devices necessary to the successful reaper that comes from a lifetime spent with agricultural implements in the field, the writer can say that not one could have been successfully operated even in the hands of an expert mechanic of this day. In Stevens's Book of the Farm, published in 1847, there is found a description of the earlier machines of Smith, Ogle, and Bell. It appears from these descriptions that Smith persevered with his machine and that he had it in the field as late as 1837. The Smith plan, however, was wrong; the revolving cylinder, with the knife attached to its outside, could not be made to do the work. Ogle abandoned his machine after having one built, and of Bell's the book goes on to state:

> The cause to which its failure can be attributed is the complicated structure of the cutter.

(*b*) *Causes that produced the reaper.*—Following out the idea that peculiar conditions produce special machines, it is fitting that the most ingenious of farm machines should have been invented, built, and introduced by an American. A hasty résumé of American agriculture

will show the peculiar conditions that have contributed to the development of the reaper through its various stages, ending with the self-binding harvester. This résumé will also show what a factor farm machinery has been in American progress, in its commerce, and its civilization. I have spoken heretofore of the average size of the farms in the United States as being 137 acres, and to the average size of the holdings in France, Germany, Belgium, and Holland, as being about 5 acres. It is plain that with all other conditions the same, the necessity of cultivating such large areas of land would develop processes that would differ from the plans and methods on the smaller farm. Added to the large size of the farms was another factor, that of a scarcity of labor. In a new country, with a great stretch of fertile lands, much of which was ready for the plow, and with a liberal Government that freely gave these lands in large farms to those who would comply with its most liberal requirements, it is plain that farm labor would be extremely scarce, as all those who would have been farm laborers under severer conditions became farm owners. The youth of the farm, as soon as he became of age, moved to the West and took up a farm of his own. The public domain was far in advance of the needs of the people. Many of us have had an idea that the flood of people that has yearly poured into our ports since 1830, spread over the great West and at once began the work of turning over the prairies. Statistics, however, show that only one in eight of the foreign-born people in the United States were on the farms in 1880—812,000 foreigners on the farms to 6,491,000 in the cities, scarcely more than had landed at our ports in a single year. The farm has not had its share of labor, properly accounted for by the long hours, hard work, and lack of companionship. The cities have been growing with greater rapidity than has the country, and between the years of 1880 and 1890 statistics show the proportion of people engaged in agriculture declined 2 per cent. All this called forth the labor-saving farm tool, and it may be safely said that no other nation has done so much in the way of improved appliances for the farm. The logical outcome of our system of agriculture has been the cultivation of the largest amount of land with the least possible amount of capital and hand labor, two items which are costly. It is admitted that even the fine farms of France have not given so favorable results to the individual agriculturist as has the system of low farming in vogue in America returned to the American farmer. Too many foreign writers have been prone to call our system of agriculture "bad agriculture," but when the profit of the American farmer is figured, it has been found that even though he has harvested a smaller number of bushels per acre, nevertheless by distributing his labor and expense over a large number of acres, he has produced a larger profit than have those farmers in regions of so-called "high culture." To return to the subject under considera-

tion, the American system of farming has been made possible only by the American labor-saving farm tools, and the great plains of the Mississippi and the Missouri have only been turned into vast fields of waving grain and tasseling corn by the American system of agriculture. In all this the reaper has played the most conspicuous part.

(*c*) *To whom the honor of invention is due.*—In 1851, after investigating the subject of the invention of the reaper and after having their attention called to Ogle and Bell, the jury of awards of the first world's fair at London reported that—

> It is certainly strange that we should not have had it (McCormick's reaper) over before, nor indeed should we have had it now but for the great exposition to whose originator (the Prince of Wales) the English farmer is clearly indebted for the introduction of the most important addition to farming machinery that has been invented since the thrashing machine first took the place of the flail.

The judges, not content with this, impressed with the wonderful importance of the new invention, and of the great value that it would be to the agriculturists of England, reported:

> At the opening of this century it was thought that a successful reaping machine had been invented, and a reward was voted to its author by Parliament. The machine was employed here and abroad, but from its intricacy fell into disuse.
>
> Our farmers may well therefore have been astonished by an American machine which not only reaped their wheat, but performed the work with the neatness and certainty of an old and perfect machine. Its novelty of action reminded one of seeing the first engine run on the Liverpool and Manchester Railroad in 1830. Its perfection depended on its being new only in England, but in America the results of repeated disappointments and untired perseverance. The United States Patent Office says of Mr. McCormick's reaper: "In agriculture it is, in my view, as important as a labor-saving device as the spinning-jenny and power-loom in manufactures. It is one of those great and valuable inventions which commence a new era in the progress of improvement and whose beneficial influence is felt in all coming time."

At the great international exposition held at Paris in 1855 there were several reaping machines shown and tested in the field. Bell's machine, or a modified Bell, the shears having been replaced with McCormick's reciprocating knife, working through fixed fingers, was put into the field, but failed to work because it could not be guided. The Manny reaper was quite satisfactory in operation, and was second to the McCormick in the field trial. The question of "to whom belongs the honor of the invention of the reaper" was argued with much spirit. The Englishmen claimed that Bell was the inventor of the first practical reaper, while the representatives of the Manny machine put forth the claims of Hussey. The jury was composed of leading agriculturists and mechanics, and they stated:

> On the McCormick invention all other grain-cutting machines are based, and not one of the imitations equals the original.

At Paris, at the great exposition of 1867, Eugene Tisserand, director-

general of the international domains, in his report published by the international commission, stated:

> The man who has labored most in the general distribution, perfection, and discovery of the first practical reaper is assuredly Mr. McCormick, of Illinois. Equally as a benefactor of humanity and as a skillful mechanician, Mr. McCormick has been judged worthy of the highest distinction of the exposition.

The report of this same exposition, written by M. Aureliano, stated:

> It is Mr. McCormick who invented the first reaper; he occupied himself with this question from 1831; and in 1851 there was seen for the first time figuring at the exposition at London a model reaper. We have thought it necessary to give some details on the origin of the reaper, and in particular on those machines of Mr. McCormick, which are, it may be said, the type after which all others have been constructed.

At Hamburg in 1863 Mr. McCormick was awarded a grand prize for being "the builder of the first practical reaper," and at Paris in 1878 he was elected a member of the French Academy of Sciences for "having done more for the cause of agriculture than any living man." In the Patent Office exhibit of the United States Government in the Government building on the grounds of the World's Columbian Exposition was a model of the first McCormick reaper, with a descriptive tag attached, which read: "The first practical reaper, invented and built by Cyrus H. McCormick in 1831." I have examined the reports of all the great international expositions that have been held and find that the McCormick machine received the highest awards at each one of them. It thus appears that the scientific juries of all the great expositions in the past have decided that to McCormick belongs the honor of the invention of the reaper. A simple plan of allowing the reader to decide for himself would seem to be to go through the early patents and descriptions of machines and select the first that contains the essential elements that time has shown to be necessary for a practical reaping machine. All reaping machines for the last fifty years have contained the following elements, viz, a framework mounted on wheels, which framework is fitted with projecting fingers along which a reciprocating knife is given motion by a crank; a platform to support the grain after it has been cut; a reel to lift the lodged and fallen grain, support it for the knife, and place it upon the platform, and a divider projecting ahead of the knife to separate the swath to be cut from the field of grain—the power to operate the knife and reel being derived from the ground wheels by the forward advance of the machine. The universal use of these elements during all these years justifies the statement that they are essential in reaping by machinery.

(*d*) *The essential elements first in McCormick's machine.*—From what has been said heretofore in relation to the English machines it is clear none of them contained the devices which time has shown are essential. Turning, then, to the American machines, the Bailey of

1825 was fashioned after the English experiments of its time, having for a cutting apparatus a revolving cylinder, to which an annular knife was attached, and the Manning was a center-cut machine, with the cutter bar ahead of the horse and the frame of the machine behind the horse. No machines of the kind were ever built, the patents being merely on ideas.

From the old files of the Lexington Union, a newspaper published at Lexington, Va., is an account of a reaping machine. This account was afterwards copied by the Mechanics' Magazine and Register of Inventions and Improvements, and can be found in volume 1, No. 5, 1833. Especial attention is called to the description of this machine, as it is the first which contains the elements that I have heretofore pointed out as being essential and arranged as they are found to-day. The article begins:

> We have omitted until now to furnish our agricultural friends with an account of a machine for cutting grain, invented by one of our ingenious and respectable countrymen, Mr. Cyrus H. McCormick, and which we witnessed in operation in a field of grain during last harvest in the neighborhood of this place.

The article is followed with testimonials of James McDowell, afterwards governor of Virginia, Archibald Walker John Weir, and others.

> JULY 18, 1833.
>
> I have seen Mr. Cyrus H. McCormick's grain-cutting machine in operation for two seasons. It cut for me this season. * * *
>
> JOHN WEIR.

Between the publication of this article and the next harvest two patents on reapers were granted by the United States Patent Office, one to Obed Hussey, Cincinnati, Ohio, and one to Cyrus H. McCormick on the machine described in the foregoing article. Hussey's machine had two main wheels in place of McCormick's one, the main frame portion being more in the form of a cart from which the cutter bar projected to one side. There was a platform supported by a third wheel at the rear behind the cutter bar, on which the grain fell and from which it was pushed by the operator onto the ground in the rear of the machine and in the way of the machine in making its next round of the field. The machine had neither divider nor reel. His patent, however, claims only an improved cutting apparatus and side-draft machine. The side draft, however, was disclaimed by Hussey in 1848, and in the same disclaimer he stated that his cutting device was a combination of two old elements. McCormick's patent claimed an organized machine containing all the features which are essential to a practically operative reaper. There is, therefore, no conflict between the Hussey and the McCormick machines except on the cutting apparatus. On this feature, however, my curiosity was aroused as to which was first to conceive, and I find the sworn statement of

Hussey that he conceived his ideas of a reaping machine in 1833, and that he built his machine immediately after for the harvest of that year. The article in the Lexington Union carries McCormick's machine back to 1832, while a letter in the Mechanics' Magazine, published in 1834, by Mr. McCormick notifies all people that he considered himself to be the inventor of the reaping machine, that he had his first machine successfully at work in the field in the harvest of 1831, and that it contained for the first time a reciprocating knife driven through fixed fingers by a crank. It is clear that the international jurors of London in 1851 and Paris in 1855 carefully studied this question, and that they were right in placing the honor of the invention of the reaper upon Cyrus H. McCormick.

(*e*) *The pioneering of a new invention.*—There is, however, in the writer's view, as much honor in the pioneering of a new device, in the introduction of it and the education of the people to use it, and in the overcoming of prejudice against it, as there is in the mere conception of the idea. Mr. McCormick was not only the inventor of the reaper, but he was the pioneer in its introduction to the world. He kept at his invention year after year. He never changed his ideas. He never changed his original plans. He worked at the minutiæ of the different devices as have other men in later years, and as inventors will continue to work so long as the reaping machine gathers the harvest. After working, planning, and building a machine, he took it into the field and demonstrated its successful operation. Even then he could get no one to build it, and on the home farm in Rockbridge, Va., he, with his father and brothers, built as many of them as they could. He would then go into the country on horseback, selling his machines with the understanding that they should do the work or they need not be paid for. In the fall of 1844 and spring of 1845, after soliciting sales for machines through Ohio, Indiana, and Illinois, he succeeded in getting 100 of them built at Cincinnati for the harvest of 1845. The following paragraph is quoted from Ardrey's American Agricultural Implements:

> There is probably no single case on record in the history of agricultural implements of an inventor who surmounted greater obstacles or who showed more heroic persistence in the development of an idea than Cyrus H. McCormick. The world has produced few such men in any branch of industrial knowledge. Mr. McCormick found the world cutting its grain with sickles; he left it with reapers in use on a million farms.
>
> The name of McCormick has become inseparably connected with the invention of the reaper, and a monument of gratitude to the memory of the man whose work as the pioneer in the reaper industry is destined to pass into history as one of the greatest contributions to human progress. * * * It is sufficient for the purpose of this sketch and for the average man to know that of the score or more of inventors who, before McCormick's time, saw the vision of a reaper that would harvest the grain of the world, not one was able to arrive at the combination of mechanical principles that would make the vision a reality.

(*f*) *Self-rake reapers.*—In 1851 Palmer & Williams built a reaper with an automatic rake to remove the grain from the machine. Their patent was for a rake and a platform so shaped as to allow the rake to sweep across it. This patent was reissued, and it furnished the basis for Seymour & Morgan's old "New Yorker." Perhaps the next most important improvement was the "jointed-bar" machine, built by Sylla & Adams, of Elgin, Ill., in 1853. This machine was the first of the jointed-cutter bar type. There were numerous forms of reaper rakes devised and used by different manufacturers during the next ten years.

(*g*) *Harvesters.*—While the numerous inventors were working to produce automatic rakes that would sweep the platform and remove the grain therefrom in gavels, the Mann Brothers, in 1849, built a machine in which the grain fell upon an endless apron and was carried to one side and delivered into a hopper. When this hopper had sufficient grain for a bundle it was dumped by the driver. Sylla & Gifford, in 1853, put a box on the machine in the place of Manns' hopper, into which the grain was delivered, and in which box men rode and bound the grain. Several years after this, in 1858, the Marsh Brothers, of DeKalb County, Ill., built a table in the box onto which the grain was delivered from the harvester, so that the men would not have to stoop and pick it from the bottom of the box. It is plain, in order to deliver the grain upon the table, the elevator had to be lengthened, so as to carry the grain up somewhat higher than the Manns carried it in their machine. In 1851 Watson & Renwick patented the first automatic self-binding harvester, and the modern self-binding grain harvesters are patterned after it.

(*h*) *Wire and cord binders.*—The automatic devices for binding grain were first practically successful in 1873, in which year Mr. S. D. Locke, of Hoosick Falls, N. Y., sold the first automatic binder attachment. It bound with wire, and continued in use for some years. The Gordons were working at this time and succeeded later in perfecting a practical wire binder, which was built by D. M. Osborne. In 1872 Charles B. Withington, of Janesville, Wis., patented a wire binder, taking the wire from two spools. This plan was perfected by Cyrus H. McCormick and brother, and became the most successful of all the automatic binding attachments using wire. Wire, however, was not the best binding material, and Marquis L. Gorham, of Rockford, Ill., in 1874, built the first successful automatic binder, making bundles of the same size. It used cord as the binding material. This patent came into the possession of the McCormick Harvesting Machine Company, and this company licensed all manufacturers of binders, with the exception of the Buckeye Company of Akron, who disputed the patent. In one of the most important decisions ever rendered in a patent cause in America, the United States court of appeals held that

the Buckeye Company was holden to the McCormick Harvesting Machine Company for the use of this patent, and that the patent contained the essential features now used by every automatic self-sizing cord binder. John F. Appleby, after seeing this machine in the field, improved it in some minor details, and for this his name is usually associated with the twine binder. Parker & Stone, of Beloit, Wis., who with Dr. E. D. Bishop furnished Appleby the means to carry on his experiments, built one hundred Gorham binders as improved by Appleby, and they were a practical success in the harvest of 1878. They were the first cord binders ever sold. So successful did the machine demonstrate itself that licenses were taken under the Appleby patents by all the leading manufacturers of this country, and it has been copied even to its most minute features by every builder of harvesting machines in foreign countries.

(*i*) *Low-down binders.*—A low-down binder was exhibited by the McCormick Harvesting Machine Company, and successfully worked in the field trials at Wayne, that was novel in design and operation, the bundle being discharged from the machine by a fork that turned it completely over so that the butts first struck the ground at the rear of the machine. It is known as the Severance binder, and has been sold in foreign markets for the past six years by Adriance, Platt & Co., of Poughkeepsie, N. Y., as licensees of the McCormick Harvesting Machine Company.

The magnitude of the immense areas in the United States that are devoted to the raising of wheat, oats, rye, and barley, and to the raising of grasses to be harvested for hay, is hardly told when we say that 37,000,000 acres are planted in wheat, 27,000,000 in oats, and about 8,000,000 in rye and barley, while the meadows take 50,000,000 acres more. These crops, much of the value of which depends on harvesting at the proper time, are practically dependent upon the reaping and mowing machine. Hereafter a paragraph will be devoted to the effect of agricultural implements, and especially the self-binding harvester, on the growth of rice, while the successful operation of a self-binding harvester for cutting and tying corn (maize) into bundles of a size convenient for handling makes it pertinent to here speak of the tremendous cornfields of the United States—72,000,000 acres. While it is true that millions of acres of cornstalks are wasted, nevertheless, as the value of the stalk is becoming better understood, millions of acres are being harvested by the self-binding corn harvester.

XIII. FIELD TRIALS OF REAPING AND MOWING MACHINES.

My colleague, Prof. R. H. Thurston, has written a report on the field tests of harvesting machines. The Wm. M. Whitely Company, of Muncie, Ind., and the McCormick Harvesting Machine Company, of Chicago, Ill., brought mowing machines to the field to be tested by the

judges, and the McCormick Company brought reapers and self-binding harvesters.

(*a*) *Special features on mowers.*—The McCormick mowers had features that impressed me as being very valuable in giving strength and extreme light draft to the machine. The direct connection between the doubletree and the rocking shoe to which the bar is attached is, in my opinion, the most valuable of the modern, patentable features in use in mowing machines. The team thus pulls from the point of resistance, and the draft connection being attached to the shoe at a point in front of the pivot of the shoe to the coupling frame, the draft is, therefore, applied to the outer end of the cutter bar, thus holding the whole bar in a right line. The sagging back of the outer end of the cutter bar causes the knife to bind in the guards, and connecting rods, and knife heads and backs to be broken. This connection of the draft rod to the shoe allows the cutter bar to be rocked on its pivot so that the points of the guards can be thrown up and down, and the finger bar is thus permitted to follow the surface of the ground, rising over obstructions and dropping into depressions. Two types of the McCormick mower were shown, one having a finger bar 5 feet long, and the other 7 feet long. The 5-foot mower on the soft soil of the meadow at Wayne, cutting timothy and red-top that averaged more than 2¼ tons per acre with a dynamometer standardized by the custodian of the United States Government's weights and measures, averaged in draft 152 pounds. And the 7-foot mower in the same field and grass averaged 201 pounds. The Whitely mower with a cutter bar 5 feet long averaged 201 pounds, the same as the McCormick 7 feet. I account for the light draft of the McCormick mowers on the following grounds, viz, the application of the power to the point of resistance, simple gearing, and superior construction.

(*b*) *Special features on harvesters and binders.*—The McCormick Company had three self-binding grain harvesters with bundle carriers at work in the field. The trial occurred in a piece of heavy oats, plots of which were lodged and badly tangled. The machines operated with the highest degree of efficiency. They cut and bound the lodged and tangled crop without being strained, and had a capacity far beyond that taken by the work. The open-end harvester and binder, a machine having the rear elevator sideboards removed and the upper elevator apron supported on a yoke that extended rearwardly beyond the machine, was efficient in the long grain, permitting the heads to extend to the rear of the machine and be transported to the binder without being retarded by obstructions. A third roller between the end rollers of the lower elevator impressed me as being a desirable feature. I noticed that the tendency of the grain to slide rearwardly between the aprons was overcome, and it seemed to me the third roller prevented the aprons from sagging and forming a depression for the grain to

slide into. An award was granted on the mowing machines and on this harvester.

(*c*) *Knot-tying mechanism.*—An award was recommended by the judges on the simple knot-tying device with which the McCormick machine was fitted. It is very doubtful whether the next fifty years produces a more simple mechanism for this purpose. It has but two moving parts, which operate slowly, one making a revolution and the other but half a revolution each time a bundle is bound.

(*d*) *Bundle-transport attachment.*—The self-binding harvesters were fitted with a common-sense bundle carrier. It was of the platform kind, from which the bundles slid by merely dropping the rear of the platform when a load had been accumulated. It had this novel capacity for a platform bundle carrier, viz, it could swing to the side of the machine beneath the binding attachment and thus get out of harm's way when obstruction was encountered, and a strong spring drew it back into receiving position without help from the driver when the obstruction was passed.

XIV. THE ADAPTATION OF MACHINERY TO THE CULTIVATION OF RICE.

The attention of the judges was called to a machine for cutting and binding rice, exhibited by the McCormick Harvesting Machine Company, and I learned that about 300 McCormick self-binding harvesters of this type had been sold during the season of 1893 for use in the rice fields of the United States, most of which machines went to the rice fields of Louisiana. It is estimated that the capacity of a man has increased 500 per cent during the last seven years in the growing of rice. Sixty-five per cent of the total rice production of America has come from the Louisiana fields during the past five years. There can be no doubt but what an individual raising rice in America can till, in fact, can perform all the stages of rice cultivation from the leveeing, plowing, reaping, and thrashing of 100 acres of rice with as great ease and with as little outlay of manual labor as the rice grower of any other country in the world can till 10 acres. This being true, and the McCormick Company having made the harvester an assured fact in the harvesting and binding of the crop, there is no reason why the United States should not raise more rice than any other country, and in place of importing, as it does, 150,000,000 pounds per year, that it should not supply its own requirements and export many millions of pounds besides. Rice is a crop that produces double the amount per acre to wheat, and which sells at about the same price per bushel, and it seems strange that this country should be importing it in such large quantities when we have millions of acres of untilled rice lands. But stranger still is it that the Americans eat so little rice when it contains 3.12 per cent more nutriment than corn and rye, 3.45 per cent more than wheat, and 11.97 per cent more than oats. When compared with

potatoes and meats the difference is still greater in favor of rice. Dr. Franklin, in his comparative value of foods, says that "A pound of rice yields more than four times as much nutriment as a pound of potatoes, and three times as much as lean meat." Under the tariff of 1894 the duty was 88 per cent on rice, and still we imported nearly 150,000,000 pounds. It will take but a few years for our labor-saving farm machinery to change all this.

XV. CORN-HARVESTING MACHINES.

There was exhibited for the first time a self-binding corn (maize) harvester. As far back as 1850 the Patent Office shows various forms of devices for harvesting corn. The earliest idea was for a machine to be driven through the field and gather the ears of corn from the stalk, which was left standing. This plan was followed by machines to cut the corn and gather the stalks into bundles on the machines and then drop them in unbound piles in the field, which piles were afterwards gathered and stood on end, forming large shocks. The next stage in ideas was to cut the corn and form the shock on the machine and then deposit the shock on the ground. For thirty-five years the inventors figured, experimented, built machines and tried them, but during all this time a successful machine was not produced. In the meantime the farmers were realizing that the cornstalks made valuable food for farm animals, and the scientific journals and agricultural papers began to publish statements that the food value of the constituent of the stalk would go as far in producing fat and muscle as the ear itself. The forty or more different agricultural colleges of the country began conducting experiments in feeding; the professors attended the agricultural meetings throughout the country during the winter months, and soon the value of the cornstalk, the part of the plant that had been wasted, became better understood, and these millions of dollars of food products demanded some more easy means of harvesting.

(*a*) *Practical plan is to bind stalks into bundles.*—The McCormick Harvesting Machine Company had a machine on exhibition and in the field trials at Dunham's farm that deserves more than passing mention. In my opinion it will form the type of successful corn harvesters and binders, as McCormick's Gorham binder has formed the type of grain binders. The machine bound the corn into bundles of a size suitable for handling. It was a very simple machine in construction. Gathering prongs projected from the machine, one on each side of the row, and slanted upwardly and rearwardly from their points. Upon these prongs chains with teeth were mounted to pick up the lodged and bring back the leaning and tangled corn to the binding mechanism, which was set on end almost directly in line with the row. A reciprocating knife was vibrated across the stalk passageway between the prongs to sever the stalks. The corn was bound while still standing on end, and dis-

charged to the side of the machine out of the way of the machine and team in the next round of the field. At the Dunham farm two of these machines were shown at work. One had the horses immediately behind the machine and pushed the machine ahead, while the other was pulled, the horses walking at the side of the row to be cut. The machines performed very well, cutting and binding the corn into bundles, picking up the lodged and tangled corn, and demonstrated that they were a great saving over hand labor. It was stated that the machine had been in use since 1889; that several of them had been sold and were in successful operation. The bundles were well formed and tightly bound, and being bound while standing on end had very square butts, which seems to me to be particularly desirable in shocking. Practical men with whom I talked assured me that bound bundles were much more easily handled than loose stalks. I was assured that laborers could handle one-third more stalks when bound into bundles than when in loose piles. In drawing the stalks to the silo from the field where four teams were necessary with the loose stalks in piles, three teams did the work with the stalks in bound bundles. The stalks when bound kept in so much better alignment that the laborer who fed the stalks to the ensilage cutter was able to put one-quarter more stalks through the machine when bound than when unbound, owing to the more even feed and to the fact that the ensilage cutter could be kept more nearly to the maximum amount of work. I was interested in the manner in which the neighboring farmers, especially those in the dairy business, handled the corn that had been cut and bound into bundles. A farmer who had used one of the McCormick machines for three seasons told me that after the corn was bound by the machine it was stood into large shocks in the field that it might cure, and then in the fall that it was drawn to the feed yard and stacked, similar to grain; that the bundles were pitched onto the wagon, and from the wagon to the stack, the same as were bundles of grain. During the winter these stalks with their ears were run through a machine that tore the stalks into shreds and separated the ears of corn, husking the ears, and delivering them into a wagon or cornerib.

The bundle was bound with a single band, which was placed on the butt end of the bundle, close to the ears. The ears of corn could readily be picked from the stalks without untying the bundle, and the amount of stalks in the bundle was about sufficient for a ration for a cow.

Wm. Deering & Co. had a self-binding corn harvester on exhibition at their space in the implement annex. It was a machine of a type more nearly resembling the automatic grain harvester, inasmuch as the cornstalks after being cut fell upon an endless apron that carried them over the main wheel of the machine to a horizontal binder, where

they were bound and discharged. The knife that severed the stalks in this machine was placed at the rear of the frame and the stalks were bent forward before being severed, and were elevated with the tops to the front of the machine rather than to the rear, as is common in self-binding grain harvesters. I did not approve of this plan, and think the machine must be a failure because of the ears of corn that would be torn from the stalks while the machine was breaking the stalks forward. In the McCormick binder of the vertical type the corn is transported but 30 inches from the time it is severed until it is bound, whereas in the horizontal binders it must be moved a far greater distance to reach the binding mechanism, thus consuming power, increasing the draft of the machine, and, worse than all, the handling of the corn breaks many of the ears from the stalks.

(*b*) *Importance of corn harvesters.*—But few of the farmers of the great central corn belt of the United States are engaged in dairying. Corn is their principal crop, and it is raised for the ear. The farmer cares nothing for the stalk. He goes into the field in the fall and gathers the ears from the stalks, which are left in the field. To the north of this great belt is a zone taking in northern Iowa and southern Minnesota, northern Illinois and southern Wisconsin, southern Michigan, New York, and the New England States, where corn is cultivated for the food elements contained in the stalk as well as for the ear. The region just described is the great dairy belt of the United States, and the progressive farmers have determined by practical experiment that there is as much food value in the stalk of corn as in the ear. In this region the self-binding corn harvester is destined to be on every farm. In the regions just named agriculture is diversified. Thirty years ago the farmers raised wheat, but as conditions changed new wheat-raising regions were developed where wheat could be more cheaply produced. The progressive farmer found it necessary to stop raising wheat alone in order to make his farm profitable, and he began to plant different kinds of crops and to save them. As time goes on the farmers of the great central corn belt will be forced into more diversified lines of farming, the corn self-binding harvester will come into more extended use, cattle will be raised to consume the fodder, and from being dependent upon one crop the corn-belt region will continue to improve and more profitable farming be made possible by the McCormick Vertical Corn Harvester.

XVI. HAYING TOOLS.

In natural order, following the harvesting of hay with the mowing machine, came the devices that have been invented and developed to make possible the handling of the great acreage of hay that is harvested in the United States. It is plain that the increased capacity given the

farmer by the mowing machine led inventors to design such facilities for handling the hay as would allow the mowers to be used to their full capacity.

(*a*) *Rakes, tedders, and sweeps.*—Loudon, in his Encyclopedia of Agriculture, written in 1831, shows several forms of wheel horserakes. They do not differ from the modern horse hayrakes in principle. The driver walked behind the rake head, and by means of handles lifted the head to discharge its load. While late years have adapted the horse hayrake so that the driver rides and unloads the rake by a lever that rolls the teeth usually on the axle of the rake as a center, still it can not be said that there has been any great increase in the efficiency of horse hayrakes during the past half century. Loudon also shows a hay tedding machine, and while it is of the revolving type and lacks the symmetry of the all-steel tedders of to-day, with their crank shaft carrying walking forks, still for effective operation in loosening hay there is probably little advantage in the modern one. In fact, Mr. Dunham had on his farm an old tedder that was very effective, that worked on the principle described by Loudon as being in use in the English hayfields in 1825. Loudon also shows a "hay swoop" which is described as being an "implement for drawing or sweeping the accumulations to the cart or rick." Implements for the same purpose are used in our prairie States, and while they have been made more effective, still in principle and operation they are almost identical with "the swoop."

(*b*) *Hay loaders.*—The hay loaders are an American tool. The trial of these machines was held before the judges at Wayne, on July 19. Three loaders competed, viz, the Keystone, the Deere, and the Beck. The Keystone loader, built on Faust's plan, was the first successful hay loader, and consists of a cylinder with rocking bars, in which are positioned teeth that gather the hay from the ground and deliver it upon an endless carrier that carries it diagonally upward and delivers it upon the wagon, to the rear of which the loader is attached. A driver on the wagon drives the team so that the loader will collect the hay, and men take the hay delivered by the loader and spread it over the wagon, forming a load. The Deere loader was of a newer type. It operated very similarly to the actions of men, were they stood on the hind end of a hay wagon with hand rakes, with which they would rake the ground and draw the hay up an inclined platform. The Beck loader, while of the same general type as that of the Keystone in that it raked the hay upon an endless carrier that carried it onto the load, still, in place of a cylinder with teeth to do the entire work of raking the hay and throwing it upon the endless carrier, it had a supplemental endless carrier that assisted the cylinder in getting the hay upon the carrier. Each of these machines was awarded a prize.

(*c*) *An example of efficiency of hay tools.*—Something of the effi-

ciency of hay-making machinery can be judged by the magnitude of the operation on Mr. Dunham's farm. He started five mowers into a field of 250 acres at noon. The next morning they were kept busily at work. At 10 o'clock he started hay tedders. At noon he began drawing hay to the barn. Two hay loaders were used, and five teams were upon the hay wagons. The unloading was done by hayforks, two forks attached together being used, of the double-harpoon variety, one for each end of the load. The loads averaged more than one ton each. Three large Percherons were used on the forks, so that it seldom took more than one double fork load to clear a wagon. Any small amounts of hay left on the wagons were thrown onto the ground by the driver, and when enough had accumulated a forkful was made of it. In six hours 114 loads were put into the barn, thus averaging more than 19 tons an hour.

(*d*) *Hay fork and carrier.*—The hayfork is made much more effective by the hay carrier, and a track that extends along the ridgepole of the barn. When the fork, with its load of hay, is raised to the carrier on the track, it releases a lock, and the carrier with the load of hay is drawn along the track to any place in the barn desired, when the driver, by a small cord that has followed the load, can dump the fork and draw the carrier and fork back to take another load. J. W. Provan, Oshawa, Ontario, showed an improved hayfork and carrier upon which he received an award. F. E. Myers & Bro., of Ashland, Ohio, had on exhibition a very effective arrangement of double steel rails for the purpose of a track for the carrier, a construction which appeared to have ample strength to transport the heaviest loads. J. E. Porter, of Ottawa, Ill., the pioneer hay fork and carrier manufacturer, having been in this line since 1869, showed his practical appliances. This manufacturer gave an impetus to the hayfork and hay carrier that placed these devices in thousands of barns. They are a labor-saving device, as there is no more laborious work on the farm than the pitching of hay from the load into high doorways or upon high stacks.

(*e*) *Baling presses.*—The baling press has been known for generations. Boxes filled with the material to be compressed, having covers to which were attached various forms of screws, wedges, levers, and pulleys, so as to increase the power of the operator, have been in common use for many years. When the box had a bale compressed into it, the mechanism was stopped and the bale removed by taking it out of the top of the box or by opening the side. This was the plan until P. K. Dederick, of Albany, N. Y., a pioneer hay-press manufacturer, invented and perfected a continuous press, one in which the material is forced by a plunger into a horizontal, rectangular box of a length greater than the bale to be formed. The delivery end of the box is made somewhat smaller than the receiving end, and in pressing

the material through it sufficient power is taken so that the material will be greatly compacted. After the box is sufficiently filled to give the resistance necessary, a board with creases is slipped into the box and the material again fed in and forced against the board. When sufficient material has been fed in to form the sized bale required, another board with creases is fed in and strong wires slipped through these creases in the boards and tied tightly around the compressed material between the boards. This is done by an attendant while the machine is still in operation, and a continuous baling is thus maintained. The material is fed to the reciprocating plunger in small quantities and a much more compact bale is formed than as though the box were filled and then compressed as a whole, in the old way. In response to the invitation of the judges, the Dederick steel press was the only one exhibited at work before the judges at the Dunham farm. The steel press of this manufacturer showed great capacity and marked superiority in construction in the form of its devices and in the materials used. Later the Collins Company, at Quincy, the Famous Manufacturing Company, of Chicago, and the Kennard Company, of Minneapolis, arranged trials of their presses and requested the judges to attend. As before remarked, however, there can be no comparison of the results obtained at the Dunham farm with those obtained elsewhere, under different conditions of hay and with the improved facilities which these special trials afforded.

While it is true that no great part of the tremendous hay crop of the United States is exported, still none of it could be without the improved baling press. As a factor, however, in inland commerce, the transportation of hay plays an important part. Hay in bales is the almost exclusive roughage food of the millions of horses and other herbivorous animals owned in the cities and towns of this country.

XVII. GRAIN THRASHERS AND CORNSHELLERS.

As long as grain has been raised it has been shelled. Rude contrivances were known to the ancients, some of which were provided with rollers to be drawn over the grain spread upon the thrashing floors. The flail has been known among the Japanese for many ages. The modern type of the thrashing machine—that is, the one with the revolving cylinder with teeth, and having an opposite concave plate also provided with teeth—is only about one hundred years old. With a fanning mill attached to clean the grain, forming a separator, it is less than one hundred years old. A Scotchman by the name of Mickle was the first to make a thrasher of the modern type. Improvements in various details, in order to separate the grain from the straw and to clean the grain of foul seeds and trash, were first invented, and later, since the steam engine became more common and fitted with means to propel itself from farm to farm, other forms of labor-

saving attachments have been added to the thrashing machine, such, for instance, as baggers to deliver the clean grain into sacks, self-feeders and band cutters to more rapidly deliver the grain to the machine, and stackers to carry the straw as it is delivered from the machine to the stack, and provided with mechanisms to swing the delivery end of the stacker in a circle. The latest attachment is an improved stacker consisting of a tube through which the straw is blown by a rapidly revolving fan. These devices require a great amount of power, and in proportion as the power lessens, in that proportion must the capacity of the machine decrease and the various labor-saving devices be removed. On some of the small farms in the old countries hand-power thrashers are still in use, in which men turn the cylinders by cranks. This mode of thrashing is in marked contrast to that practiced on the farms of the United States. There is no more imposing sight on an American farm than a modern thrash ing outfit, such as was shown by the Geiser Manufacturing Company, of Waynesboro, Pa., and the Stevens Company, of Auburn, N. Y., at the Dunham farm. The Geiser separator demonstrated its ability to thrash and clean 500 bushels of oats an hour when operated with the 12-horsepower traction engine owned by Mr. Dunham. The wonderful rapidity of its action is but in keeping with the progress and capacity of the other American labor-saving farm tools which plant and reap.

(*a*) *Large amount of power required.*—The first thrashing machines were located at the mills where water power could be had to give them motion. In America the Pitts Brothers, of Winthrop, Me., in 1830, improved the so-called railway or tread powers, and they became popular for giving power to small stationary separators. With a power that could be moved from place to place, it was a natural development to combine the old stationary thrashing machines with a fanning mill, aud mount them on wheels so they could be drawn from farm to farm. Pitts Brothers did this in 1837, and their patent shows the first of the endless-apron separators that became so common. These brothers were also pioneers in adapting horsepowers for practical use, and they arranged them so that the power could not only be drawn on trucks from farm to farm, but, by attaching numerous long levers or sweeps to the power, as many as five or six pairs of horses could be attached to the sweeps. However, the capacity of the separator continued to increase, and devices to save labor continued to be attached to them, until the horsepowers could no longer furnish satisfactory power to do the amount of work required. Then the traction engine, which had been known for a hundred years or more in England, was taken up, improved, and developed so that the engine would not only furnish power itself from farm to farm over the country roads, but it would also draw the wagon containing its water tank, and behind this the

separator, and behind the separator the automatic straw stacker. Could the people that saw Fulton's first steamboat on the Hudson have seen at the same time a modern steam-power thrashing outfit moving along a country roadway, their wonder would have been greater than was their astonishment at seeing a boat moving through the water without sails or oars.

Goold, Sharpley & Muir, Brantford, Ontario, showed a bagging attachment, as did W. A. Gewlawney, of Tara, Ontario, while the Huber Manufacturing Company, of Marion, Ohio, showed a traction engine with an attachment for burning straw. The Frick Company, of Waynesboro, Pa., had on exhibition and showed in operation a traction engine, while the Geiser Manufacturing Company, of the same place, had a very capable engine for giving power to their large separator. A. W. Stevens & Sons, of Auburn, N. Y., exhibited a 12-horsepower traction engine. The different exhibitors that have just been named received awards. The separators and engines in particular excited the admiration of mechanics because of their marked adaptability for their purpose, excellent design, and symmetrical construction.

(*b*) *Cornshellers.*—If the modern grain thrasher and separator, with its various attachments, are mammoth machines, so are the cornshellers that shell the kernels of corn from the cob and which consume the power from the largest of the traction engines. The hand cornsheller, with its single hole into which ears are fed by hand, has developed, in order to meet the requirements of our Western corn-growing States, into machines that have endless-chain belts extending into the corncribs upon which two and three men, with large scoop shovels, shovel the ears of corn, and these belts carry the ears to the shellers in which eight and ten and even twelve shelling disks are mounted. The shelled corn comes forth in a stream at the rate of 600 bushels per hour, and great piles of cobs are soon accumulated. The rapidity of operation is in keeping with the 72,000,000 acres of corn that this country produces. The Keystone Manufacturing Company, of Sterling, Ill., the Sandwich Manufacturing Company, of Sandwich, Ill., and the Whitman Manufacturing Company, of St. Louis, Mo., showed cornshellers of the most modern type.

(*c*) *Feed-grinding mills.*—Mills for grinding feed on the farm were shown in great numbers. They consisted of crushers, grinders, cutters, and feed mills. Prizes were awarded to nine different exhibitors in this class, and they were from widely separated localities. Perhaps no other incident shows more clearly that farming and feeding in the United States has become more than the raising of a single kind of crop and the feeding of grain in its natural condition.

(*e*) *Windmills.*—It will be remembered that class 89 included those farm tools which make possible the economies of labor on the farm,

and that windmills were of this class. To the south of the agricultural building the slim steel towers stretched toward the sky, and bore trim steel wind wheels and vanes at such heights that the great buildings of the Exposition seemed to conduct the wind upon the wheels rather than deflect it from them. An old Dutch wheel with its extending arms and clumsy vanes was in marked contrast to the trim and symmetrical wheels that seemed to be always running with a speed that promised effective work, whether it be in lifting water, grinding grain, or in other uses on the farm. The Aermotor Company, of Chicago, showed its all-steel wheels of different sizes, from 8 feet up, the metal of which, after the wheels had been made and joined together, was galvanized as one piece, thus preventing the rusting of the joints. The United States Wind Engine Company, of Batavia, Ill., had an attractive exhibit, which included gearing to make the windmill effective in giving power to feed and grinding mills. The Stover Manufacturing Company, of Freeport, Ill., The American Well Works, of Aurora, Ill., The Beloit Wind Engine Company, of Beloit, Wis., and the Decorah Windmill Company, of Decorah, Iowa, and other companies exhibited windmills, pumps, tanks, feed grinders, cutters, and water-supply fixtures.

There were various other farm tools shown, but space prevents giving them the notice that their merit deserves.

XVIII. MAGNITUDE OF THE FARM IMPLEMENT MANUFACTURING INDUSTRY IN THE UNITED STATES.

The American agricultural implement is at work in all lands. It performs more effectively than any other, whatever may be the country where it is put to work or the nationality and prejudice of the operator. There are more than 1,000 manufacturers that are making agricultural implements exclusively in the United States, with an aggregate capital of $200,000,000, and employing more than 50,000 hands, and the value of those products is $100,000,000. The magnitude of some of the great manufacturing establishments, such, for instance, as the McCormick Binder and Mower Works, places them among the great industries of the world. This company employs 3,600 skilled laborers in its works, has 1,600 salaried agents exclusively engaged in doing its business, and more than 9,800 local agents selling its machines in every country in the world where grain and grass are grown. Its great works occupy more than 66 acres of floor space, and one complete machine is finished each minute of the working day; and it builds and sells one-third of all the grain and grass cutting machinery of the world.

The 5,000,000 farmers of the United States constitute a vast body of wage-earners on whose prosperity, intelligence, and moral worth is based the welfare of the Republic. Their experience with the labor-

saving farm tools has taught them that they are more than rude instruments of toil, and they have become intelligent factors in both a social and political sense. The improved farm implement has given them an ability to produce far beyond the ability of any other tillers of the soil. In 1855 Hon. William H. Seward stated that the invention of the reaper by McCormick added $55,000,000 annually to the wealth of the farmers in the United States. The ability to make the farm pay has made our farmers believers in education, in the progress of the sciences, in political purity, and they are informing themselves on the great topics that are engaging the thoughts of our statesmen. The labor-saving farm tool has given to the United States an intelligent agricultural class which in patriotism and love of country has no equal in any land.

FERRIS WHEEL.

BY

LUTHER V. RICE.

FERRIS WHEEL.

By Luther V. Rice.

During the early days of the preexposition period the engineers and architects of all America who were interested in Exposition matters formed a Saturday afternoon club, at which engineering and architectural features of the Fair were discussed.

At one of these meetings Mr. D. H. Burnham asserted that the architects of America had covered themselves with glory and enduring fame by their artistic skill and original designs of mammoth buildings, while the civil engineers had contributed little or nothing either in the way of originating novel features or of showing the possibilities of modern engineering practice in America. Some distinctive feature was needed, something to take the relative position in the World's Columbian Exposition that was filled by the Eiffel Tower at the Paris Exposition. Towers of various kinds had been proposed, but towers were not original; all that could be done in that line would be to out-Eiffel Eiffel; that is, build a larger tower than was built by him. But mere bigness was not what was wanted—something novel, original, daring, and unique must be designed and built if American engineers were to retain their prestige and standing.

Seated at the table, listening to Mr. Burnham's remarks, was a tall, slight, young engineer, with a pale, resolute face. This was George W. G. Ferris, senior partner in the firm of G. W. G. Ferris & Co., bridge builders and inspecting engineers. Cut to the quick by the truth of these remarks, he registered a vow that he would design and build something which would be a credit to his profession. After casting several things over in his mind, the idea of a great observation wheel came to him like an inspiration. That night, in the company of a small party of friends, he rapidly sketched his plans in the rough.

The inspiration of the moment was the stroke of genius. The original sketch was so perfect that it was carried out in its entirety; not a single change was made. Returning to his home in Pittsburg, Mr. Ferris immediately set his draftsmen at work making detail drawings. Mr. W. F. Gronau was placed in immediate charge of this work. Strain sheets were made, and the stresses were computed for every possible load or strain to which the wheel could be subjected. This was no easy task, as Mr. Ferris's plans were for a tension wheel, and the

stresses for such a structure had never before been computed. There was absolutely no data upon the subject, no precedent to follow, so the methods of calculating and designing had to be originated and thoroughly proven by mathematical demonstration.

In the spring of 1892 Mr. Ferris went to the ways and means committee of the World's Columbian Exposition with his plans for a vertical revolving wheel 250 feet in diameter and capable of carrying 2,260 people at a load. His ideas were accounted as those of a visionary and an enthusiast. He became known as the man with wheels in his head. But he was deeply in earnest, and in June a concession was granted him, only to be revoked the next day. One member of the committee said that the wheel would be a "monstrosity," and out of keeping with the dignity of the Exposition. Others thought it a waste of time to further consider a thing that would crtainly be a failure. Even engineers doubted its practicability. Some claimed that it could not be built, others that it could not be operated even if it was built. In spite of all opposition, however, Mr. Ferris kept quietly at work organizing a company to build the wheel, and renewed his efforts to secure a concession. Capitalists were not very eager to invest in a scheme which was apparently so chimerical in its nature as this one, but this quiet and enthusiastic young engineer inspired confidence, and finally the stock was almost all taken.

Renewed and persistent efforts to secure the concession to build the wheel inside the grounds finally resulted in a concession being granted for this purpose, not in Jackson Park itself, but in Central avenue, Midway Plaisance. By the terms of this concession, which was granted December 16, 1892, the Ferris Wheel Company was to retain the first $300,000 received from the sale of tickets, after which one-half of the gross receipts were to be paid to the World's Columbian Exposition. It was now midwinter and only four months until the opening of the Exposition. The mills, machine and bridge shops over the country were full to overflowing with orders. Most men would have hesitated even then because of the seeming physical impossibility of constructing such a massive piece of machinery in so short a time. But Mr. Ferris never hesitated an instant. His intimate knowledge of the mills and machine shops throughout the country, gained in his business as a bridge builder and inspector, was now of incalculable value to him and to his project. No one shop could begin to do all the work, therefore contracts were let to a dozen different firms, each being chosen because of some peculiar fitness for the work intrusted to it. The firm of G. W. G. Ferris & Co. was called upon for an army of trained inspectors, who rigidly examined all work in the different shops. Absolute precision was necessary, as few of the parts could be put together until they were upon the ground, and an error of the smallest fraction of an inch might be fatal.

Meanwhile the foundation work, which Mr. Ferris had placed in charge of Luther V. Rice, was proceeding slowly and under many difficulties. The winter was the most severe that Chicago had experienced for many years; the frost at the wheel site was 3 feet deep; the quicksand was 20 feet in depth and saturated with water. All of this had to be excavated, and a solid concrete monolith, interspersed with steel beams resting upon piles driven through blue clay to hardpan, 32 feet from the surface, was built to get a secure foundation for the towers. Pumps were kept running night and day to keep out the water, and live steam had to be used to thaw the sand and broken stone. On the 20th day of March, 1893, the first tower post was put in place. Soon after came the problem of raising the axle. This axle, which bore the entire weight of the wheel, cars, and people, was forged by the Bethlehem Iron Company, was 45 feet long, 32 inches in diameter, and weighed 45 tons. Upon the axle were two immense spiders or hubs, each weighing 12½ tons. This immense weight of 70 tons was lifted 140 feet and placed in beams upon the towers in two hours' time. The spokes, which were adjustable iron rods 2$\frac{9}{16}$ inches in diameter and 80 feet long, were then suspended from the hubs. The wheel had an outer and an inner rim or felloe, the latter being 45 feet inside of the former. The wheel was in reality a double one, or two wheels attached to one axle with a spacing of 28½ feet between them, thoroughly tied together with struts and diagonal rods, and the rim was composed of 36 sections, built up in the same manner as bridge chords. Between the two rims and attached to the spoke rods was a stiff spoke or post. Starting from the bottom and working in both directions, these sections were attached one by one and securely bolted together. Above the axle the rims of course gradually approached one another as section after section was put in place, until finally the last section was hoisted 264 feet and the two parts of the rim were joined, which made the circle complete.

Meanwhile the power plant has been put in place. The boilers were on Lexington avenue between Sixtieth and Sixty-first streets, over 700 feet away and outside of the grounds. Steam was conveyed to the engines by an underground 10-inch wrought-iron pipe, the exhaust steam being carried back to the boilers by a second underground pipe. The mighty 1,000-horsepower engines were in place and power was transmitted to the wheel by a triple set of gear wheels which run a sprocket chain, the pins of which fitted in the serrated teeth of a cast-iron segment securely bolted to the outer chord or rim.

As soon as the last connection was made preparations were immediately made to turn the great wheel. Mr. Ferris was in the East on pressing business when the final connections were made, but had given parting instructions to turn the wheel or tear it off the towers. It was a critical moment. Steam was admitted into the cylinders and

the engines started. Trusted men were at every point to watch the action of every piece of mechanism. The wheel revolved steadily and surely and the doubting Thomases were silenced.

When it was seen that the wheel was moving, the foreigners in this street of many nations came running from all sides, shouting vociferously and gesticulating wildly. The wheel had been an enigma to them; now they hastened with their weird and uncanny musical instruments to celebrate this glorious triumph of American industry and skill.

Between the outer rims of the two wheels the cars for carrying the people were swung on pins or pivots 6½ inches in diameter. These cars were 26 feet long, 13 feet wide, and about 9 feet high, with plate-glass windows and a door at each end. Thirty-eight fancy twisted-steel chairs were in each one. There were 36 cars in all, 1 being hung at each panel point at the extreme end of the spokes.

On June 11 a trial trip was made with 6 cars. The wheel had not been adjusted and the superintendent wished to make one trip around to see how it would act. Mrs. Ferris, who had cheered her husband in the darkest hours of the enterprise and had given many words of encouragement to the men in charge of the construction work, was present, and bravely determined to make the first trip. She did not falter one moment, nor did she show one sign of fear while making that perilous trip. Upon her return to earth Mr. Ferris was wired the particulars and immediately telegraphed back, "God bless you, my dear."

The opening day was set for the 21st of June. Speeches were made by Capt. Robert W. Hunt, president, and Judge William A. Vincent, secretary, on behalf of the company, while Maj. Moses P. Handy spoke on behalf of the World's Columbian Exposition. Other speakers were Gen. Nelson A. Miles and, last, Mr. G. W. G. Ferris. In a happily framed speech he called attention to the fact that he had "gotten the wheels out of his head and made them a living reality." The final success of his scheme he feelingly attributed to his wife, Margaret A. Ferris. In closing he dedicated his work to the engineers of America. Mrs. Ferris then presented him with a golden whistle, which he blew as a signal for starting the wheel. The Iowa State band struck up "America" and the great wheel slowly and majestically revolved, while the air was rent with cheers by the assembled thousands.

Although the wheel was perfectly safe in itself, yet accidents might occur which would bring it into disrepute. To guard against this every precaution possible was taken by the management. Doors were locked and heavy iron screens covered the windows of the cars, making it impossible for a person to get out while the wheel was in motion. There were six platforms on each side at different elevations, so that six cars could be loaded and unloaded at once, the people coming in at

one end of the car and passing out at the other. Upon each platform was stationed a uniformed guard, whose business it was to open platform gates and car doors, allowing the people to pass into the car. After the car was filled each guard closed the door of his car and signaled the engineer by an electric bell and annunciator that his platform was clear. Not until he had the signal from each platform did the engineer open the throttle. To insure his control of the wheel it was equipped with double Westinghouse air brakes, which effectually controlled its movements under all conditions. Uniformed conductors in each car answered the questions of the wheel patrons and, when necessary, soothed their fears. Not one of the one and three-quarter million passengers carried was injured in any way. The story of the pug dog jumping out of one of the car windows was concocted by some space writer who was short on news and long on invention. Equally false were the reports that the wheel stopped for some hours with a number of people in the top cars. The wheel ran upon the schedule time of twenty minutes for the double round trip from the time it started until the close of the Fair. There were no delays or halts of any kind. The engine always had up steam and there was always a clear track and no breakdowns.

This record of almost five months' constant running for such an intricate mass of mechanism without a single hitch is simply marvelous. It is an added triumph to American engineering ability and skill.

Arrangements were made at an early date for the installation of an electric-light plant in the boiler house. The current was carried by underground wires to the wheel. The towers, fence, and wheel were studded with 3,000 incandescent lights. But though the night view from the wheel was equal to a glimpse of fairy land, the night trip never became popular.

The capacity of the wheel was never taxed; even on Chicago day when there were 34,433 paid admissions. During the months of June, July, and August few people were carried before 11 o'clock, and the heaviest hour's business was between 5 and 6 in the afternoon. In September and October, however, as many people were carried between 9 and 10 a. m. as between the heavy afternoon hour. On the 19th of October there were 1,784 people on the wheel during one trip. The largest number of people carried in any one hour was about 4,000.

The paid admissions to the wheel on week days was about 9 per cent and on Sunday about 12 per cent of the paid admissions to the Exposition. If each visitor made an average of eight trips to the Fair, the percentage of separate people in attendance carried by the wheel was about 70. The patrons were from all stations of life. The rich and poor, high and low, senators, governors, farmers, merchants, mechan-

ics, and laboring men all seemed equally anxious to take a ride upon this novel wheel. Letters were received from several couples who wished to be married in the highest car. Two of them went so far as to have their invitations printed inviting their friends to the Ferris wheel to see them married in one of its cars. The management was not seeking notoriety, however, and they were forced to be content with a wedding ceremony performed in the office of the superintendent.

The view from the wheel on a clear day was magnificent, but as the patronage upon a dark, smoky day was nearly as large as upon a perfectly clear one, the conclusion is almost forced upon one that the people were much more interested in the daring design and unique structure planned and built by Mr. Ferris than they were in landscape views or effects, no matter how beautiful they may have been.

FISH AND FISHERIES.

BY

W. R. CAPEHART.

FISH AND FISHERIES.

By W. R. CAPEHART, *Judge.*

Having been appointed judge of Department D, fish and fisheries, and assigned to the duty of examining groups 38, 39, and 40, and requested to report on group 38, I have the honor to report as follows:

Having carefully examined all articles in group 38, department of fish and fisheries, made by the different nations at the World's Columbian Exposition, I am permitted to contrast the most approved appliances and methods adopted by each nationality for catching fish, and by the people of different sections of the same country. From the simple bamboo trap employed by the Siamese hundreds of years ago for fishing in their sluggish shallow streams to the great wide-mouthed beam trawl used on the coast of Great Britain, towed by powerful steamers, and gathering in their great cods every fish coming within their immense mouths, and from the hand-made minnow net of Japan to the immense product of the machine netting companies of Boston and Gloucester in America, and of Itzehoe, Germany.

No man knows when hooks, nets, trawls, and seines were not used for catching fish. Our most ancient records show each was in use, but the progress has been constant and great, especially in the past hundred years, culminating in our great netting plants and steam-power seine fishing, and the use of preservatives, such as tanning, tarring, and other waterproof compounds, which when applied to flax or cotton thread material, in use, increases the longevity of the material so treated.

With increasing population, our ingenuity has been taxed to meet the demands for fish food, and we have progressed from the catching of a single fish in the ancient dip net to the great hauls made in the steam-power drag seine now in use in the shallow sounds of North Carolina, reaching as much as 40 tons of herring or 30 tons of shad and 13 tons of striped bass at a single haul. (See Harper's Monthly, May, 1880; also photograph of actual haul landed, showing 188,000 herring, 1,500 shad, and large quantities of other fish in one net.)

From the employment of a single pot fishers we have progressed to that of 8,000 men at a single locality, the Astrakhan fishery of Russia, resulting in a catch of billions of fish (many varieties) in a single season.

When we contrast the models of nets used in Japan and other countries four hundred years ago with our own great seines, miles in length and depth required for the waters fished, we can but feel justly proud of the results. The great steam-power seines of America and the beam trawls now in use off the coast of Great Britain seem to meet almost every demand. While the netting and trapping of fish have made great strides, the commercial fisherman, with hook and line, has not been left behind. It has been my pleasure to examine every manner of hook from the bone hook, made by the painstaking savage, to the harpoon used by the hardy whaler, and from the hand-made minnow hook of the Japanese artisan to the highly polished and tempered hooks turned out (by the millions) from the great factories of Europe and America. Progress has been the watchword with the rope and line maker as well. From the grass and bark hand-made rope in use in the Eastern countries, and by our Indians of the Pacific coast, we have reached what seems to be perfection in the material for hanging our great seines and nets. The hemp rope manufactured in Russia and other European countries and by the great cordage companies of America, and the silk, flax, and cotton cord of this country and Great Britain, furnish the best material for commercial trawls and hand lines, thus meeting the demands of all fishermen. The floating materials for seines, nets, and lines have likewise been much improved, from the use of pieces of buoyant wood to the copper-wired goose-egg cork of the present day.

FISHERIES EXHIBIT.

BY

L. Z. JONCAS, Judge.

FISHERIES EXHIBIT.

By L. Z. Joncas, *Judge.*

London had an international fisheries exposition in 1883, but it is the first great World's Fair in history that has had distinctive department of fisheries. The fisheries exhibit is the first of its kind ever held in this country, and every man who pulls line or net, and every one who is interested in fishing for commerce or sport, should appreciate the effort that has been made by the World's Fair management to give to fish and fishing a standing in the affairs of the world such as has never been accorded on similar occasions.

"There can be no question," writes Capt. Joseph W. Collins, chief of the department of fisheries, in the New York Fishing Gazette, "that this action is appropriate. A country whose yearly commerce was developed through fisheries, whose free-school system was first inaugurated and supported through income from fishing, whose fishermen not only aided in establishing its liberties, but have on all occasions maintained the dignity and honor of its flag, might well contribute a new feature to expositions, when holding the greatest fair the world has ever seen, a feature which has been so markedly attractive and instructive to the public that it will doubtless be incorporated in all future enterprises of the kind."

No structure of the Exposition has attracted more attention or has been more universally admired than the fisheries building.

The term "fisheries" in its most limited sense is ordinarily understood to apply only to the taking of free-swimming fish. In recent years, however, it has a much wider application, when considered from a commercial standpoint. When we speak of fisheries to-day, it is understood that the term applies to the obtainment and preparation of all kinds of aquatic products. The food-fishes are not the only objects of pursuit. Innumerable are the uses of fish and other aquatic products, marine and fluvial. Fish products alone make possible the most delicate perfumes on any lady's dressing case; the rarest gems that encircle her throat or arms come from creatures of sea and river that live and die to furnish them, while the beautiful and costly furs that cover her form and the wonderful tortoise-shell combs that hold in confinement her wealth of hair are all results of fishery. Sea monsters are dissected for their oil, bone, or ivory, while others furnish leather or shagreen, so much admired when prepared for use. Even the scales of fish are transformed into beautiful jewelry, shells are deftly worked into pictures and wreaths of flowers or are carved into cameos of marvelously delicate tints.

Thus the capture of whales among the ice fields of the far north or under the tropic sun, the hunting of walrus and sea otter, the driving, killing, and skinning of fur seals in Bering sea or on the islands of the Antarctic Ocean, the diving for pearls, corals, and sponges, or the obtainment and curing of sea weed for food or fertilizer are now considered fisheries from a commercial standpoint, and from this point of view come in the same category as the catching and curing of cod, mackerel, and many other of the well-known species of fish that inhabit the seas, lakes, and rivers.

The harvest of the sea has not yet been attended to and garnered to the same extent as that of the land. Some nations, such as the Chinese, Japanese, etc., have, it is true, long given close attention to the profitable utilization of its commercial products, and several European nations and the Americans have also prosecuted certain fisheries, but systematic and scientific arrangement has only of late years been specially directed to various branches which have been termed pisciculture, aquiculture, and ostreiculture, and the transfer of the fishes from one locality to another. By all civilized and commercial nations the products of the sea have been accounted fully as important as those of the land. The sea is more abundantly stocked with living creatures than the land. In all parts of the world a rocky and partially protected shore perhaps supports in a given space a greater number of individual animals than any other station. The sea is filled with animals of several kinds, and each layer of water in depth seems to have its own varieties, thus resembling the changes which take place according to elevation in the organized portions of the land.

The fishery question is therefore of urgent consequence to the people generally, and any information ought to be welcome which increases our knowledge of the fishing grounds within our reach; for the fisheries are not only of importance to us in consequence of the vast amount of wealth that can be drawn from the deep, apparently without diminishing or exhausting its source, but because by these means a body of able and hardy seamen may be found to conduct the commerce of a maritime country during peace and to become its gallant defenders on the ocean in time of war.

Besides many valuable individual displays, eleven States of the American Union and thirteen foreign countries have contributed to render the fishery exhibit most complete and most interesting.

The objects of fishery were gathered in great profusion in the fishery building, and we can not do better than to quote again what Capt. J. W. Collins writes on this subject:

> Practically everything that comes from the sea, lake, or river to serve the purpose of men as food or in the arts or sciences was included in this collection. Fish of all the earth—living, represented by casts, by photographs, by paintings, or preserved in alcohol—were competing in friendly rivalry. Monstrous devil fish, sharks, and other grizzly terrors of the deep were seen beside delicate and beautifully tinted pis-

catorial dandies from distant Australia or Japan. Aquatic mammalia, such as otters, minks, seals, sea lions, whales, dolphins, and white bears, appear on every hand. Mollusca of innumerable forms, including oysters, pearl shells, clams, mussels, and iridescent abalona, appear in scientifically arranged groups or as representing features of commercial industries.

These were supplemented by tortoises, turtles, terrapins, lizards, crocodiles, and various other forms of reptiles; also by star fishes, sea urchins, and holothurians. Sponges from Greece met here the inhabitants of deep-sea grottos, the coral animal—builder of islands and continents—sea anemones that blossom miles below the surface of the ocean, and specimens of subaqueous life so marvelously delicate and so richly beautiful that the microscope will only reveal in part the wondrous beauty and film-like tracery; while aquatic birds from northern Europe and America stood opposite those from Japan and Australia.

Fishing gear of innumerable forms and varying utility was met with at every turn, and one found it difficult to determine whether there was most interest in the rude wooden hook and kelp line of the northwest coast Indian or the effective devices employed by white men which capture whole fares of fish in a single day.

Then there are lay figures and photographs of fishermen and representations of their manner of living; illustrations of the methods of fishing, showing how the captures are effected and how the products are cared for on shipboard. Associated with these are representations, by model or otherwise, of fishing towns, the processes of curing fish, packing establishments, etc. In this manner is traced the whole subject of fishing, not only from the standpoint of natural history, but also from the building of the fishing vessels or boats through all the manifold processes until the various products of fisheries are ready for the consumer.

Intimately related to this is the science of fish-culture, and here one finds representations of what man is doing and has done to maintain abundance of fish in waters that have become depleted through overfishing or by other means. Commerce in its greed has depopulated many streams, often by pollution, and even our Great Lakes—those brothers of the ocean—are feeling the effect of the drain upon them. Man must in such cases restore, if possible, the abundance he has destroyed, and for this purpose he must resort to artificial propagation.

The American public has an opportunity never presented to it before to become acquainted with fish and fisheries, not only of this country, but of all the world; and in view of the exceptional interest and the intelligence which has been universally displayed by visitors in inquiring concerning exhibits and in noting their principal features, there can be no doubt that the influence exerted by this department of the World's Fair will be very beneficial and helpful to all who are interested in fisheries and to the public generally.

I will not undertake to give a comprehensive review of the many exhibits of the fisheries department. It would require pages of description to give anything like an adequate idea of them all. My remarks will be confined to the most important and the most interesting.

Among the foreign countries which have taken part in this great exposition in the department of fisheries Norway, Canada, New South Wales, and Japan have occupied prominent places. Owing to the destruction by fire of the cold-storage building, where it had many of its best exhibits, Norway, unfortunately, decided not to compete.

Canada had a very large exhibition of stuffed fish and fish prepared for food, which shows the richness of its fisheries.

The yearly value of the commercial fisheries of Canada reaches nearly $20,000,000, the most valuable kinds of salt-water fishes being cod, salmon, herring, lobster, and mackerel. The total value of cod in 1892 yielded over $4,000,000. Salmon comes next, with a value of $2,500,000; then herring, $2,000,000; lobster, $2,000,000, and mackerel, $1,500,000. The progress of the lobster-canning industry has been almost phenomenal. In 1869 it yielded only $15,275. Four years later it had grown up to $1,000,000, while in 1881 it reached the highest point on record, viz, $3,000,000. There are fully 626 canneries now in operation. The traps and other plant used by these establishments are valued at over $1,000,000. Smelts are also found in immense quantities all over the maritime provinces, while the salmon fisheries of British Columbia, yielding over $2,500,000 every year, are so well known as to need no other description.

The inland waters of the Dominion teem with white-fish, salmon, trout, pickerel, bass, speckled trout, ouananiche, sturgeon, muskellunge, etc., the most valuable of the above being the white-fish, the catch of which amounted to 23,776,000 pounds in 1892, valued at $1,500,000. Sturgeon, salmon, trout, pickerel, and bass also form a valuable adjunct to the wealth of those waters. The salmon rivers of Quebec and New Brunswick are justly famous, as every admirer of the gentle art in the United States knows.

In Canada cod tongues and mackerel are now preserved in cans by a process unknown ten years ago, and a new industry has just been established in the province of Quebec to can in oil the small herring which in large quantities frequent the shores of the St. Lawrence. This small herring preserved in pure olive oil is very carefully put up, and competes favorably with the French sardine itself.

As shown by the report of this committee already submitted, the Japanese turn into an article of food every fish frequenting their waters. By a process of their own they even turn seaweeds into isinglass, jellies, and printing paper of superior quality, and their ingenuity and industry are really wonderful.

We observed that in every country of the world great care and

attention are given to the preparation of fish as food, and great progress has been made in this respect during the last ten years, especially in fish canning.

Russia was exhibiting caviar of a superior quality, and the extract of oysters from Japan, together with the Japanese mode of curing shellfish of every description, has been very much admired.

Amongst the States of the American Union that contributed largely to the interesting display of the fishery building are Rhode Island, Oregon, North Carolina, Minnesota, Washington, Wisconsin, California, and Maine.

As is well known, the State of Oregon has for many years been the chief center of the salmon-canning industry of the Pacific coast of the United States, and naturally it was expected that the fisheries exhibit of Oregon would inclose a large representation of the products of the salmon fishery. This expectation has been realized. Oregon had a very large and very complete collection of canned salmon, and every one almost of the specimens submitted to our examination was of the highest commercial standard, and the packages in which the fish were preserved were especially remarkable for their neatness and finish.

California had also a full exhibit of the food fishes of the Pacific coast. For the first time in the history of the coast there were presented correct models in flexible plaster casts of a great many of the food fishes of that State.

Minnesota showed sketches of fishing grounds, photographs of fishery grounds, of fishes, of boats, of angling, and mounted specimens of fishes. This last collection was a very complete representation of the fish fauna of the State.

The Rhode Island exhibit illustrated in a graphic, comprehensive, and meritorious manner three of its most important fishery industries, namely, the menhaden fishery, the deep-water trap fishery, and the scallop fishery. In addition to this it exhibited appliances and fishing gear used for catching lobsters, eels, etc.

The menhaden industry was systematically arranged as follows: First, the object of the fishery, full-sized specimens of menhaden are shown in alcohol; second, full-sized examples of boats, purse seine, and other equipments used for the capture of menhaden are exhibited, these representing the highest attainments reached in those forms of boats and apparatus. The advance that has been made in some of the appliances used for the manipulation of the seine was illustrated by showing old forms in conjunction with the new. Third, the most improved types of fishing vessels were represented by excellent rigged models of fishing steamers. One of these is the first steamer built for the menhaden fishery, and the first steam vessel ever constructed in the United States exclusively for employment in commercial fishing. Another model represented one of the largest, swiftest, and best-

equipped steamers now engaged in this industry, and illustrated the advance that was made in building this class of vessels in a few years, an improvement due largely, if not entirely, to the success which attended the introduction of steam into this fishery. The methods of fishery were well demonstrated by a model of a purse seine placed in the position such as it would occupy when first set. This was supplemented by a series of enlarged photographs illustrating the various phases of fishing from the time the vessel starts on her trip until she returns and discharges her fare. One photograph shows a steamer leaving the harbor, several others represent different stages of setting and pursing a seine around a school of menhaden; one shows us the process of transferring the catch from a net to the hold of a steamer—technically known as "bailing in"—while other pictures represent the method of transferring the fish from a steamer to the vats in the factory on shore by means of an elevator. The preparation of products were similarly illustrated, from the time the fish are carried along in a "fish conveyor" to drop into the boiling vats until the oil is gathered in tanks and the refuse is spread for drying on the great yards adjoining the factories. Specimens of the products themselves supplemented the pictures. Of these, there were various kinds of crude and refined oil and samples of crude, acidulated, and ground fish scrap or fertilizer.

Incidentally, the economic condition of the fishermen was shown by photographs of a steamer's cabin, the room set apart for eating at a factory, and the houses in which the fishermen reside. Many of the latter are evidence of prosperity and comfort.

The scallop fishery was represented in a manner somewhat similar to the menhaden industry, though lacking pictorial illustration. Samples of young and mature scallops were exhibited in alcohol. A full-sized rigged catboat with her sail set, such as is used in the scallop fishery, was a prominent feature of the Rhode Island exhibit. Specimens of dredges used on different kinds of bottom, of old and new types, show the apparatus employed and the improvement made in recent years. These were supplemented by implements and apparatus used in handling and marketing the catch, such as shovels, measures, culling board, etc.

Essentially the same means have been employed to represent the deep-water trap-net fishery as are used for showing the mendaden fishery. Various species of fish such as are commonly taken in trap nets were shown in alcohol.

The State of Maine showed mainly pictures of boats which are engaged in coast fishing, and of a large and fine collection of gelatin fish casts which gave a very good idea of the fish fauna of this State and of the great variety of fish frequenting its waters, many of which are of great commercial value.

We deem it advisable to make special mention of some private exhibitors in this department, who have in a very large measure contributed to show to the world the importance of the fishery industry. We refer to the Gloucester Board of Trade, the American Net and Twine Company, J. R. Neal & Co., and Messrs. Wolf and Reesing, of New York.

The Gloucester Board of Trade exhibit was the only domestic one in the fisheries building illustrating the development and progress of American fisheries since colonial times by models of vessels, wharves, fish packing, smokehouses, etc., and by certain appliances used for navigation and other purposes. The material advancement in naval architecture as applied to the fisheries, the enlargement and improvement in the facilities for curing and packing fish, the adequate facilities for cleaning and painting the vessels, and the changes made in the fishing gear, etc., were all well demonstrated. This exhibit included models of the finest fishing schooners in the world now employed in the deep-sea fisheries; also specimens of spars and rigging of full size as proposed at Gloucester for fishing vessels.

This is the only domestic exhibit that included also equipments of fishing vessels illustrating the advance made in this direction, a matter upon which the efficiency of such vessels depends. These included anchors, steering wheels, specimen of cables, canvass, compasses, quadrants, etc.

The exhibit not only embraced representations of the largest and most prosperous fishing port in America, a port that was settled soon after the Pilgrims landed at Plymouth, but it showed the schoolhouses where fishermen's children are educated, samples of the pupils' work, and various other things illustrative of the economic condition of the Gloucester fishermen, and the advanced position now occupied by them in these regards.

The Gloucester exhibit included also much material illustration of the mechanical skill of its fishermen; among other things mention may be made of the following, which indicate a high order of intelligence: (a) Builders' models of the finest fishing schooners, (b) the entire lot of rigged miniature fishing vessels and boats, (c) the model of a full-rigged ship. This exhibit prominently displayed statistics of fisheries and valuable historical data. It embraced representations in miniature, or otherwise, of numerous forms of fishing gear of the most improved types; also samples of fishing lines, nets, and seines, specimens of fish packages, and various kinds of cured fish, all products of the industries that center at Gloucester.

The American Net and Twine Company had a most remarkable exhibit of its manufactured products, embracing all kinds of nets, from the ancient cast net to the most recent inventions in trap nets and purse seines.

An enterprising Boston firm, Messrs. John R. Neal & Co., deserves also much commendation for the fine exhibit it has made, in which it has illustrated the varying phases of the New England deep-sea fisheries. These gentlemen showed how fishing is carried on for cod, herring, mackerel, etc., with gill nets, purse seines, and trawl lines. The arrangement of the exhibits was such that one could see not only the vessels and boats above the surface of the sea, sailing or fishing, but the position of nets and lines beneath the water could be observed, while sea weeds and fish seem to float in the dim perspective of the deep.

The firm also illustrated the mode of curing the finnan haddies, of which they showed very good specimens, and they deserve much praise in their intelligent effort to inform the world of all these phases of fishing and of preparing the fish for the market.

There is always a special interest attached to industries that supply the people with food, and particularly so when a delicate and wholesome article is produced from what was considered practically worthless material, though when treated intelligently it becomes of great value and importance. For this reason, the exhibit of American sardines, which are young sea herring, somewhat similar to those canned and preserved by l'Union Sardinière du St. Laurent, of Quebec, Canada, may claim more than a fair share of attention.

Any country is much indebted to those enterprising spirits who, exploiting new fields of effort, succeed in establishing on a healthy commercial basis an industry for the utilization of material that otherwise might be unheeded and of no benefit to the nation. Therefore much credit is due to the firm of Messrs. Wolf & Reesing, of New York, for what it has accomplished in this direction, as well as for the vigor with which it has prosecuted its work and the high standard of its products, evidenced by the fact that medals have been awarded them at international expositions both in Europe and this country. In 1883 a silver medal was awarded at the Great International Fisheries Exposition in London, and another medal was awarded the same year at the exposition held at Aalborg, in Denmark. Again, in 1885, the firm was given a gold medal at the New Orleans Exposition. These awards demonstrate that the same vigorous and intelligent direction that enabled this house to pioneer the sardine industry is still characteristic of it. This is evinced by the fact that the firm has not been content simply to make an exhibit of its products—interesting alone to the expert or student—but it has also displayed, with its cans of sardines, a most instructive series of photographs which show all the different phases of catching and preparing the little fish that prove such a desirable addition to our menu.

The United States Fish Commission exhibit, which is very large and very complete, is certainly one of the most interesting and the most

valuable of all those which have been submitted to the examination of the judges on fishing and fisheries.

It covers classes 37, 38, 39, and 41, and comprises a variety of specimens which it must have taken years of labor and care to collect and catalogue.

I have no hesitation in saying that it is absolutely impossible for any man, whatever his knowledge of the fishery industry may be, to report on such an exhibit in a manner which would do it justice. After carefully examining this large variety of appliances of every description and form, one feels that it is worthy of the highest award, but that it would take pages of description to cover it and the combined knowledge of many experts in fishing matters to do justice to all its progressive features.

It is to be regretted that the decision to enter this exhibit for competition was taken only at the eleventh hour and after all my colleagues had been discharged.

As I have already stated, it is without the shadow of a doubt entitled to the highest award, but it would have been much more satisfactory for myself and for the United States Fish Commission if this award had been recommended by the whole board of judges, and if a substantial, comprehensive, and detailed report had been made upon it.

PRELIMINARY REPORT OF INVESTIGATION OF FOODS EXHIBITED AT THE WORLD'S FAIR.

BY

Prof. W. O. ATWATER.

PRELIMINARY REPORT OF INVESTIGATION OF FOODS EXHIBITED AT THE WORLD'S FAIR.

By Prof. W. O. ATWATER, *Chemist in Charge of Investigation.*

The purpose of this account is to explain very briefly the object of the investigation, and to state what has thus far been done and what, as it seems to me, ought further to be done to give the results the greatest practical value and bring them home to the people of the country at large.

Permit me first of all to explain how the investigation came to be what it is, and, in so doing, to repeat as nearly as I can recall it the conversation with yourself which led to it.

On my appointment as member of the jury and assignment to the department which included food materials, I called at your office in the administration building to learn your wishes. You pointed to the court of honor, which was in full view from the window, and said:

The underlying object of this Fair is educational. In the architecture of those buildings, the statues upon them, and the disposition of the things about them you see an example of what we are trying to do to help educate the people in matters of art. We want to do the same in the direction of science. Furthermore, we wish the influence of the Exposition to be permanent, to continue long after the Fair is done and these buildings are gone. To this end we are planning for reports which we wish to be as valuable as it is possible to make them.

One thing which we think the people of the United States ought to know more about than they do is their food; how it nourishes their bodies; what kinds and combinations of food are best for health and strength, and how they can obtain the most and best nutriment at the lowest cost.

Now we have, as we are told, the largest collection of food materials that has ever been brought together. We know in a general way that your chemists make analyses of foods and find just what nutriment they contain, and that in this way you obtain data for judging of their hygiene and pecuniary economy. Of course we do not understand the scientific details; that is your affair. But we should be very glad if you could take specimens of the food materials that are on exhibition here and analyze them. We should be pleased to have you use the results to help in deciding the awards as far as that is possible, but the main point is to get valuable information. When your investigation is done it ought to be put in a detailed report. If you can make that report so complete and accurate that it will be a standard for reference, an epitome of useful knowledge—if it can be one of the monuments of the many forms of progress in science and art and industry which this World's Fair is bringing out so wonderfully—we shall feel that your work and ours in the matter is a success. Then if you could go a step farther and boil the whole result down and crystallize out the best of the practical information and mold it into shape for everyday use—

in other words, if you could put the gist of the matter in a little book or pamphlet so simple that the ordinary man or woman would understand it, and so practical that the average intelligent housekeeper would apply it, and so useful that the Government would print copies by the hundred thousand and put them into households throughout the country, and so let this be one of the products of the Fair to be permanently useful in the homes of the people—if you could help us to do this we should accomplish exactly what we want to do.

I told you I thought the plan a most excellent one; indeed, I used a much more enthusiastic expression in the actual conversation. Practically it meant a larger, more thorough, and in every way more valuable investigation of the kind than had ever been undertaken in this country or in Europe. But I ventured to suggest that to carry it out would require a good deal of work and expense.

You replied to the effect that such an enterprise would be entirely in accord with the spirit of the Fair and the purpose of the Columbian Commission. As the outcome of the conversation, it was agreed that I should at once take measures to secure a force of competent chemists and other assistants, obtain the appliances, and make the needed arrangements for carrying on the investigation in the chemical laboratory of the University of Chicago, which had been generously placed at the disposal of the commission for the purpose.

It was then past the middle of July; the Fair was to close at the end of October. The men who would be most useful in the chemical investigations were generally connected with educational and scientific institutions, and few of them could well be away from their work except for a comparatively short time in the summer. Apparatus must be procured and set in operation. To institute such an investigation in Chicago on so short notice was not easy, but the occasion was propitious as the opportunity was rare, and with your cordial assurance of support as generous as the circumstances would allow, I entered heartily upon the undertaking.

To purchase the peculiar apparatus needed would have involved much expense and delay. To avoid these, I laid the matter before the authorities of the Storrs (Connecticut) experiment station, of which I am director, and received their very hearty sanction for the use of its apparatus. The authorities of Wesleyan University, of whose faculty I am a member, were likewise generous in aiding the enterprise. At the earliest possible moment more than a ton of packages of apparatus and chemicals thus loaned was shipped from Middletown to Chicago. Besides the tender of free use of laboratory room by the University of Chicago, its officers gave most helpful aid. Such material as could not be provided for by loan was purchased. Thus the laboratory arrangements were completed in very short time.

Meanwhile vigorous use had been made of mail and telegraph to secure expert assistance. We were most fortunate in the cooperation of the chemists who were members of the jury, Prof. G. A. Smyth,

Mr. C. D. Woods, and Dr. H. B. Gibson. The chemical force as thus gathered together included graduates of twelve American and European colleges and universities, and numbered with assistants sixteen persons Some of these, however, were employed for special temporary service and others were able to remain for only a short time.

I regard it as a privilege as well as duty to bear testimony to the efficiency of the service rendered by the gentlemen associated with me in the investigation. They realized the importance which the occasion and opportunity gave it and did their work with earnestness and enthusiasm.

At the opening of the academic year, near the end of September, the laboratory of the University of Chicago was needed for its regular use. Fortunately we were permitted by the Northwestern University to continue part of the work in the laboratory of its medical school until the close of the Fair.

At the outset some difficulties were experienced in the collecting of specimens. We received very material aid, however, from several members of the jury, both home and foreign. In this connection it would be wrong to omit reference to the very judicious, devoted, and efficient help rendered by Mr. C. H. Mixer, of Chicago, the secretary of the subcommittee on Groups II and VI.

THE OBJECT AND CHARACTER AND IMPORTANCE OF THE INVESTIGATION.

The main object of the inquiry was to get information as to the nutritive values of the food materials exhibited at the Fair and the economy of their use. The specimens selected were mostly of home products, but a considerable number of the more interesting foods from foreign countries were also taken for examination.

The majority of the specimens selected were those of animal foods, especially meats and meat products. The reasons for choosing more of these than of the vegetable foods were several. Plans had been made for examinations of the cereal products at the Fair by Professor Wiley, of the United States Department of Agriculture. Numerous analyses of cereal and other vegetable foods and of dairy products have been and are being made by the experiment stations in the different States. A large number of analyses of dairy products were made at the Fair in connection with tests of breeds of dairy cows. The meats are much more variable in composition and nutritive value than either dairy products or vegetable foods. Few analyses of meat have thus far been made. The meat industry in the United States, including fresh, smoked, pickled, and canned meats, and materials prepared from meats for table use, has assumed enormous proportions and has come to be of the greatest importance to farmers and dealers as well as to consumers. And finally, by the courtesy of a number of exhibitors and through the especial generosity of several of the great meat-

packing firms of Chicago, an opportunity was furnished for collecting materials for examination such as has never before occurred.

Nearly six hundred specimens of animal and vegetable products used for the food of man were collected for the purposes of this inquiry. The more perishable ones were first cared for. Some five hundred have now been analyzed. A number of specimens, mostly of canned foods, still remain unexamined.

Notes and other data regarding the sources, production, methods of preparation, character, and uses of home and foreign food products were collated, and arrangements were made for securing further information for a report if called for.

The Exposition brought out in a peculiarly instructive and impressive way the remarkable progress of the past few years in the collection, preparation, and distribution of food products. Our wheat and corn are conveyed from the prairies and the Pacific coast to the seaboard States and across the Atlantic in enormous quantities and with marvelous cheapness. Young cattle are taken from Texas to the Western ranches and the great corn-growing States, are fattened there, and then shipped, with those grown on the ground, to Chicago, Kansas City, and other centers, where they are slaughtered. Every portion of the carcass is utilized. Sheep and swine are treated in like manner. The fresh meat is distributed by new and ingenious methods to home and foreign markets, with a speed and cheapness hardly dreamed of a few years ago. The devices for pickling, canning, and otherwise preserving the meats and for putting them into attractive forms are as novel and interesting as they are useful. The methods of preserving vegetable foods and making palatable products for the table of them are no less important and worthy of study. Some of the methods, of course, are not made public, but the information which was to be had in connection with the exhibits at the Fair and is otherwise available would, if properly collated and published, make a valuable contribution to practical knowledge.

The progress in the preparation and distribution of food products is one of the important economic phenomena of our time. We find illustrations in the refrigerator cars for carrying meats which we see on every journey by rail, in the freighting of meat and grain and flour from the West to the East and South in our own country, and from North and South America, Russia, India, New Zealand, and Australia to western Europe. The displays of canned goods in every grocery and the export of canned meats and vegetables and other prepared food products alike witness to the same development of our food industry. Nearly all of this has grown up since the war and most of it since the Centennial Exposition of 1876.

The results of this great advance are manifold. Food is cheaper, so much so as to depress the value of agricultural lands in nearly all the

older countries of Christendom. The housewife has at her disposal a larger variety of appetizing dishes while her labor is lessened. The poor man's table is furnished with tasteful and nutritious materials which were formerly beyond his means. The advantage to the home life of the people is decided and obvious. At the same time new and larger markets for the farmer's products are opened at home and abroad and thus the producer as well as the consumer is interested. But while the effect is in a measure helpful to American producers it is not wholly so. International competition is made sharper. Hence there is increasing need that the farmer, the miller, the meat packer, and the manufacturer of prepared foods should have more exact knowledge of the facts so as to be better prepared to meet the competition. There is also need that consumers shall be better informed as to the character and especially the nutritive value of the food they purchase.

These considerations and the ways of obtaining the needed information and making it available to the public were taken into account in the investigation.

The exhibits from foreign countries in the Agricultural, Fisheries, and Manufacturers' buildings furnished much interesting material, and the foods of the odd people in the Midway Plaisance, some of which they had brought with them from their native countries, were also drawn upon. The opportunity was utilized to study the food consumption of some of these latter people. The superintendent of the Java village, whose people were highly intelligent and lived as they are accustomed to do at home, generously provided material and facilities for a careful study of a Javanese dietary. Observations were also made of the food of the Turks, and of the community of Bedouin Arabs to whom the term "Wild East" was applied, and who had their own cooks and to some extent their home diet.

In this statement I give a few specimens of the analyses as illustrations of what has been done and reference to some general conclusions which are based upon results of previous inquiry and confirmed and amplified by those of this investigation.

THE NUTRIMENT IN DIFFERENT KINDS OF FOOD—EXPLANATIONS OF TECHNICAL TERMS—ANALYSIS OF FOODS.

The subject is new, and as this may fall into the hands of some who are not familiar with the latest teachings of chemistry and physiology, a few words of explanation will perhaps be in place.

A pound of lean beef and a quart of whole milk contain about the same amounts of actually nutritive material. But the pound of beef costs more than the quart of milk, and its nutritive ingredients, or nutrients as they may be called, not only differ in number and kind, but are for ordinary use more valuable than those of the milk. This illustrates a fundamental fact in food economy—namely, that the differ-

ences in the values of different foods depend upon both the kinds and the amounts of the nutritive materials which they contain. Add to this that it is essential for health that the food shall supply the nutrients in the kinds and the proportions required by the body, and that it is likewise important, from a pecuniary standpoint, that the materials be obtained at the minimum cost, and we have the fundamental principles of food economy.

THE NUTRITIVE INGREDIENTS OF FOOD.

Edible portion and refuse.—If the reader will take the pains to notice the next piece of beef that he has to carve for dinner, he will, of course, observe first of all that, along with the meat which is good to eat there is more or less bone, which, except so far as it may be used for soup, is of no value for food. The beef, then, may be regarded as consisting of edible portion and refuse. The same is true of fish. In eggs there is a corresponding distinction between shells and the so-called "meat." Oysters and other shell fish in like manner include the shells, which are simply refuse, and the shell contents which make up the edible portion. The inside of the potato and the wheat flour are the edible portion, and the skin and bran are refuse of potatoes and wheat.

If we weigh the whole meat, bone and all, to start with, and afterwards weigh bone and other refuse and the edible meat, we can easily calculate the percentages of refuse and edible portion. Precisely this is done in the actual analysis of meats, fish, potatoes, and other food materials in the actual analysis in the laboratory. Thus in different specimens of beef, as ordinarily sold, have been found to contain all the way from 3 per cent of refuse in the top sirloin to 40 per cent in the skin. In a whole side of moderately fat beef the amount was about 20 per cent. The refuse in a side of mutton was 17 per cent; that in the different cuts of the same side ranged from 2 per cent in the flank to 28 per cent in the neck. In many kinds of food, such as oysters (shell contents), milk, butter, flour, and the like there is no refuse.

Water.—The edible portion of food, as, for instance, the flesh of meat, and fish or milk or bread, consists largely of water. Although water is necessary to sustain life that in food is of no more value than the water we drink. In food analyses it is important to determine the proportions of water. This is done by carefully expelling the water by heat and weighing the dried residue. This water-free residue contains the actually nutritive ingredients, or nutrients, of the food. The proportion of water in different food materials is extremely variable. In milk and oysters seven-eighths of the whole weight are water. Potatoes, the very edible portion of some very lean kinds of meat, and the flesh of many kinds of fish are about three-fourths water. In some

of the fatter kinds of beef and mutton and the leaner pieces of pork one-half the weight, more or less, is water. Bread is about one-third, and flour, meal, fat pork, and butter are not far from one-eighth water.

Nutrients.—The nutritive ingredients of food, those which form the basis of blood, muscle, bone, and sinew, and which are burned in the body to yield heat to keep it warm and muscular strength for work are commonly grouped in four classes—protein compounds, fats, carbohydrates, and mineral matters. If we dry out the water of meat or flour and then burn the residue, the mineral ingredients will remain as ashes. In food analysis the materials are thus burned and the percentages of mineral matters are found. The quantities of mineral matters are small, not often much over 1 or 2 per cent, unless the material has been salted. The nutrients which are chiefly taken into account in analysis are protein, fats, and carbohydrates.

Protein, proteids, and albuminoids.—The meat consists of lean and fat. Part of the fat is in large lumps, which can be easily separated from the lean. The rest of the fat is diffused throughout the lean in particles so small as to be invisible to the naked eye, but it is possible to separate them very completely from the lean by processes of analysis common in the laboratory. After the water and the fat have been removed from the lean meat the material which remains will contain a little mineral matter, which would be left as ash if it were burned. The remainder consists chiefly of compounds which are called by various names, as albuminoids, proteids, or protein.

Protein is characterized by containing nitrogen, which does not occur in the carbohydrates and fats. The protein is the chief nutritive constituent of fish and eggs, as well as of lean meat. It occurs also in the white of eggs as albumen, whence the name albuminoids; in milk in the form of casein (curd); in wheat as gluten, and in various other forms in animal and vegetable foods generally.

Meats and fish contain very small quantities of so-called "extractives." These include kreatin and allied compounds and are the chief ingredients of beef tea and meat extract. They contain nitrogen and hence are commonly classed with protein, although they are very different in character and have not the same use in the body.

Fats.—Fat is familiar to us in meat, from which we get it in the form of tallow and lard; in milk, from which it is obtained as butter; in the various oils, such as olive oil, cotton-seed oil, and the oils of wheat and corn. Larger or smaller proportions of fat are found in most food materials.

Carbohydrates.—Potatoes, wheat, and corn contain large proportions of starch. Sugar cane and sorghum are rich in sugar. Starch and sugar are very similar in chemical composition and are called carbohydrates. Other carbohydrates are found in animals and plants; such as inosite or "muscle sugar," in muscle; and glycoren, or "liver sugar," in the liver.

Ash.—The mineral matter, or ash, which is left behind when animal or vegetable matter is burned consists of a variety of chemical compounds, commonly called salts, and including phosphates, sulphates, and chlorides of the metals calcium, magnesium, potassium, and sodium. Calcium phosphate, or phosphate of lime, is the chief mineral constituent of bone. Common salt is chloride of sodium.

The number of the different chemical compounds in our animal and vegetable food materials is very large, but, leaving water out of account, it is customary to divide the rest into the classes of which we have spoken. The proportions of these ingredients are determined by the somewhat complicated methods of chemical analysis followed in the laboratory, but our everyday handling of food materials often involves processes of analysis, though of course they are very crude.

We let milk stand; the globules of fat rise in cream, still mingled, however, with water, protein, carbohydrates, and mineral salts. To separate the other ingredients from the fat the cream is churned. The more perfect this separation—i. e., the more accurate the analysis—the more wholesome will be the butter. Put a little rennet in the skimmed milk, and the casein, called in chemical language an albuminoid or protein compound, will be curdled and may be freed from the bulk of the water, sugar, and other ingredients by the cheese press, as is done in making cheese. To separate milk sugar, a carbohydrate, from the whey is a simple matter. One may see it done by the Swiss shepherds in their Alpine huts. But farmers find it more profitable to put it in the pigpen, the occupants of which are endowed with the faculty of transforming sugar, starch, and other carbohydrates of their food into the fat of pork.

The farm boy who on cold winter mornings goes to the barn to feed the cattle and solaces himself by taking grain from the wheat bin and chewing it into what he calls "wheat gum" makes unknowingly a rough sort of analysis of the wheat. With the crushing of the grain and the action of the saliva in his mouth the starch, sugar, and other carbohydrates are separated. Some of the fat—i. e., oil—is also removed and finds its way with the carbohydrates into the stomach. The tenacious gluten, which contains the albuminoids or protein and constitutes what he calls gum, is left. When, in the natural order of events, the cows are cared for and the gum is swallowed, its albuminoids enter upon a round of transformation in the boy's body, in the course of which they are changed to other forms of protein, such as albumen of blood or myosin of muscle, or are converted into fat, or are consumed with the oil and sugar and starch to yield heat to keep his body warm and give him muscular strength for his work or play.

WAYS IN WHICH THE FOOD IS USED IN THE BODY.

Food nourishes the body in two ways. It forms blood and muscle, bone and brain, and it is consumed as fuel to keep the body warm and furnish strength to do its work; in other words, it builds tissue and yields energy.

The protein compounds are the building material of the body. They are sometimes called "flesh formers," because the flesh—i. e., muscle and sinew—is formed from them, although they make blood and bone as well and can also be transformed into fat. Protein also serves to repair the wastes of the body. Thus, as muscle and tendon are used up they are built anew from the protein of the food.

The fats and carbohydrates are the fuel ingredients. Both are burned in the body, their potential energy being transformed into the fat of the body, which is its reserve of fuel. The protein can serve as fuel also, but the fats and carbohydrates can not take the place of protein in building nitrogenous tissue, for the protein contains nitrogen and they do not.

We often speak of the body as a machine. The bodily machine is made of protein. That is to say, blood, muscle, tendon, bone, and brain all consist of, or rather contain, protein compounds. These are formed from the myosin of meat and fish, the casein of milk, the albumen of eggs, the gluten of wheat, and other compounds. As the muscle and other tissues are used up in bodily activity the same materials of the food are used for their repair. Of course the mineral matters have a good deal to do with the building up of the tissues. Thus, phosphate of lime is an essential ingredient of the bones.

But the machine needs fuel. The starch of the bread and the potatoes we eat, and the sugar put in our coffee, are burned in the body and yield heat and power, just as truly as does the coal which is burned in a stove to heat the house or under a boiler to drive an engine. The fats serve the same purpose, only they are a more concentrated fuel than the carbohydrates. The body transforms the carbohydrates into fat, which it keeps as a reserve of fuel in the most concentrated form; but the protein compounds can also serve as fuel. A dog can live on lean meat. We can likewise use the protein of our bodies to supply us with heat and muscular strength. The animal machine differs from others in that it can use its own substance for fuel.

The different food ingredients can, to a greater or less extent, do one another's work. The body can use protein for fuel in the place of fats or carbohydrates; but neither of the latter can take the place of protein in building and repairing the tissues of the body.

Protein is the most important of the nutrients of food, because it can do not only its own work—that of building and repairing—but

also that of the carbohydrates in serving as fuel, while the fuel ingredients can not be used for building material. But the fats and carbohydrates can, by being burned themselves, protect the protein of the body and that of the food from being consumed. Hence they are sometimes designated as economizers or protectors of protein.

FUEL VALUE OF FOOD—POTENTIAL ENERGY.

One of the great advances which have been made in the science of nutrition within a few years past, is in determining the fuel value of food. In estimating the use of food as fuel, we simply apply to the animal body the law of conservation of energy which pervades all physical phenomena. The coal and wood which we burn contains potential energy. This is transformed into the heat of the furnace and the mechanical energy of steam. In like manner the potential energy of food is transformed in the body and manifests itself in heat and in muscular work.

It is customary to estimate the quantities of nutrients of foods in grams, and the fuel values in calories. There are 454 grams in a pound, or 28 in an ounce avoirdupois. The calorie is the amount of heat that would raise the temperature of 1 kilogram of water 1° C., or 4 pounds of water 1° F. One calorie is equivalent to 1.53 foot-tons—that is to say, the mechanical force that would lift 1½ tons 1 foot. Taking ordinary food materials as they come, the following general estimate has been made for the average amount of energy in 1 gram of each of the classes of nutrients.

Potential energy in nutrients of food.

	Calories.	Foot-tons.
In 1 gram of—		
Protein	4.1	6.3
Fats	9.3	14.2
Carbohydrates	4.1	6.3

These figures mean that when a gram of fat, be it fat of food or body fat, is consumed in the body, it will, if its potential energy be all transformed into heat, yield enough to warm $9\frac{3}{10}$ kilograms of water 1° of the centigrade thermometer (or 4 pounds of water 1° F.); or, if it be transformed into mechanical energy, such as the steam engine or the muscles use for their work, it will furnish as much as would raise 1 ton $14\frac{3}{10}$ feet, or $14\frac{3}{10}$ tons 1 foot. A gram of protein or carbohydrates would yield a little less than half as much energy as a gram of fat.

In other words, when we compare the nutrients in respect to their fuel values, their capacities for yielding heat and mechanical power, an ounce of protein of lean meat or albumen of egg is just about equivalent to an ounce of sugar or starch; and a little over 2 ounces of either

would be required to equal an ounce of the fat of meat or butter or the body fat. The potential energy in the ounce of protein or carbohydrates would, if transformed into heat, suffice to raise the temperature of 113 pounds of water 1° F., while an ounce of fat, if completely burned in the body or in the calorimeter, would yield as much heat as would warm over twice that weight of water 1°.

What has thus been said about the ingredients of food and the ways in which it nourishes the body may be briefly recapitulated. From the standpoint of their uses in the nutrition of man, the constituents of ordinary foods may be classified as follows: Edible substance, as the flesh of meats and fish, the shell contents of oysters, wheat flour. Refuse, as bones of meat and fish, the shells of oysters, bran of wheat. The edible substance consists of water, nutritive substances, or nutrients. The water and refuse (and the salt of salted meat and fish) are called nonnutrients. The water contained in foods and beverages has the same composition and properties as other water; it is, of course, indispensable for nourishment, but it is not a nutrient in the sense in which the word is here used. In comparing the values of different food materials for nourishment, the refuse and water are left out of account.

CLASSES OF NUTRIENTS.

The following are familiar examples each of the four principal classes of nutrients:

Protein:

Albuminoids: e. g., albumen (white of eggs); casein (curd) of milk; myosin, the basis of muscle (lean meat); gluten of wheat, etc.

Gelatinoids: e. g., collagen of tendons; ossein of bones, which yield gelatine or glue, etc. The albuminoids and gelatinoids are commonly classed together as proteids.

Meats and fish contain very small quantities of so-called "extractives." These are the chief ingredients of beef tea and meat extract. They contain nitrogen, and hence are commonly classed with protein.

Fats: e. g., fat of meat; fat (butter) of milk; olive oil; oil of corn, wheat, etc.

Carbohydrates: e. g., sugar, starch, cellulose (woody fiber), etc.

Mineral matters: e. g., calcium phosphate or phosphate of lime, sodium chloride (common salt), etc.

WAYS IN WHICH FOOD IS USED IN THE BODY.

Food supplies the wants of the body in several ways. It either (1) is used to form the tissues and fluids of the body; (2) is used to repair the wastes of tissues; (3) is stored in the body for future consumption; (4) is consumed as fuel, its potential energy being transformed into heat or muscular energy or other forms of energy required by the body; or (5) in being consumed protects tissues or other food from consumption.

USES OF THE DIFFERENT CLASSES OF NUTRIENTS.

Protein forms tissue (muscle, tendon, etc., and fat) and serves as fuel. Fats form fatty tissue (not muscle, etc.), and serve as fuel. Carbohydrates are transformed into fat and serve as fuel.	All yield energy in form of heat and muscular strength.

In being themselves burned to yield energy, the nutrients protect each other from being consumed. The protein and fats of body tissue are used like those of food. An important use of the carbohydrates and fats is to protect protein (muscle, etc.) from consumption.

THE DIGESTIBILITY OF FOOD.

"We live upon not what we eat, but what we digest." In other words, the value of food for nutriment depends not only on how much of nutrients it contains, but also upon how much of these the body digests and uses for its support.

By digestibility of food several different things are, or may be, meant. Some of these, as the ease with which a given food material is digested, the time required for the process, the influence of different substances and conditions on digestion, and the effects upon health and comfort are so dependent upon the peculiarities of different individuals, and are so difficult of measurement as to make the laying down of hard-and-fast rules impossible. For our present purpose, the most important factor is the amount digested. This, fortunately, is more easy to determine. Understanding by the digestibility of a food the proportions of each of the nutrients which can be actually digested from reasonable amounts of the food by healthy persons, the question becomes simpler and can be answered more or less accurately by experiment. The experimenting is, however, very laborious and costly, and but little has been done on this side of the Atlantic. Practically all of our accurate information upon this subject comes from Germany, where such research has had considerable government support. No studies of digestibility of the food materials collected at the World's Fair were possible.

The results of the European inquiry into the digestibility of food may be recapitulated in a few words.

1. The protein of our ordinary meats, fish, and milk is very readily and completely digested. The protein of vegetable foods is much less completely digested than that of animal foods. Of that of potatoes and beans, for instance, a third or more may escape digestion, and thus be useless for nourishment.

2. Much of the fats of animal food may at times fail of digestion. This is presumably true of the fats and oils in vegetable foods, but the quantities of the kinds we ordinarily eat, as flour, meal, and potatoes,

are in general so small that the determinations of the proportions digested are not very accurate.

3. The carbohydrates, which make up a large part of vegetable food, are in general very digestible. The crude fiber or cellulose is an exception, but the quantities of this in the materials used for the food of man are too small to be of importance. Sugar is believed to be completely digested. This is assumed to be the case with the sugar of milk. The other carbohydrates of animal foods are very small in amount.

4. The animal foods have in general the advantage of the vegetable foods in digestibility, that they contain more protein and that their protein is more digestible.

5. The quantity digested appears to be less affected by flavor, flavoring materials, and food adjuncts, and to differ less with different persons than is commonly supposed.

It may be added that one outcome of the careful experimenting of the last few years is the proof that there is not the difference in the amounts digested from the same kind of food material by different persons, or by the same person under different circumstances, that has been popularly supposed.

THE FITTING OF FOOD TO THE NEEDS OF THE BODY.

In the adjusting of diet to the demands of the body, the important matter is to provide enough protein for the building and repair of tissue and enough energy to keep it warm and do its work. Considering the body as a machine, there must be material to make it and keep it in repair, and fuel to supply heat and power. If there is not food enough or the nutrients are not in the right proportions, the body will be weak in its structure and inefficient in its work. If there is too much, damage to health will result. Of course, there is a great difference in the requirements of different people. The kinds and amounts of food best fitted for nourishment vary not only with sex, age, size, occupation, and climate, but also with the peculiarities of the individual. In a general way it is possible to estimate the amounts of actual nutrients needed on the average by people of different classes and occupations.

As the outcome of a great deal of observation and experiment, nearly all in Europe, standards have been proposed for the amounts of nutrients and energy in the daily food required by different classes of people. Those of Professor Voit, of Munich, Germany, are most commonly accepted by specialists in Europe. Voit's standard for a laboring man at moderately hard muscular work calls for 118 grams of protein, and quantities of carbohydrates and fats sufficient with the protein to yield 3,050 calories of energy. Well-to-do professional

men and students in Europe, with less muscular exercise than mechanics, have been found to be well nourished with an average of 115 grams of protein and 2,700 calories of energy.

TABLE A.—*Composition of food materials collected at the World's Fair.*

[Specimens with water content as collected.]

[This table contains analyses of the 496 specimens of food materials collected at Chicago, including meats taken at the stock yards. It is the first of a series of fundamental tables in which the results of the analyses are set forth. A full report will include a long series of tables prepared from this and from the descriptions of the specimens. There should be at least 100 such tables, of which several will be of the size of this and the rest smaller. Tables II-IX are examples of the smaller ones.]

Calculated to water content at time of collection

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
FRESH BEEF.							
Neck:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Native	2184	60.47	19.90	18.79	.....	0.84	1,165
Do	2280	62.99	18.83	17.28	.....	.90	1,080
Do	2447	61.76	20.41	16.91	.....	.92	1,095
Native cow	2253	64.68	19.01	15.41	.....	.90	1,005
Do	2319	60.53	18.84	19.76	.....	.87	1,185
Colorado	2215	63.56	18.71	16.87	.....	.86	1,060
Do	2265	71.04	19.95	8.04	.....	.97	710
Do	2301	62.61	18.39	18.10	.....	.90	1,105
Texas	2195	67.86	18.88	12.35	.....	.91	875
Do	2237	67.70	19.74	11.45	.....	1.11	850
Do	2485	71.84	22.31	4.88	.....	.97	620
Chuck:							
Native	2180	59.87	18.21	21.12	.....	.80	1,230
Do	2281	64.19	17.84	17.06	.....	.91	1,050
Do	2448	50.71	16.65	31.88	.....	.76	1,655
Native cow	2254	71.72	19.56	7.73	.....	.99	670
Do	2320	63.07	18.19	17.85	.....	.89	1,090
Colorado	2211	69.38	18.69	11.00	.....	.93	815
Do	2266	67.15	17.97	13.97	.....	.91	925
Do	2302	67.15	19.41	12.52	.....	.92	890
Texas	2191	71.00	19.42	8.64	.....	.94	720
Do	2233	69.51	19.39	10.15	.....	.95	790
Do	2486	73.85	21.30	3.90	.....	.95	560
Fore shank:							
Native	2185	65.52	19.39	14.17	.....	.92	960
Do	2282	67.52	19.61	11.95	.....	.92	870
Do	2449	58.94	18.61	21.64	.....	.81	1,260
Native cow	2255	71.04	20.05	7.93	.....	.98	705
Do	2321	67.62	19.49	12.00	.....	.89	870
Colorado	2216	69.93	22.50	6.70	.....	.87	700
Do	2267	69.99	19.22	9.87	.....	.92	770
Do	2303	68.71	20.19	10.16	.....	.94	805
Texas	2196	73.13	20.51	5.43	.....	.93	610
Do	2238	73.12	20.59	3.35	.....	.94	610
Do	2487	74.64	20.80	3.60	.....	.96	540
Plate:							
Native	2181	45.01	12.43	41.91	.....	.65	2,000
Do	2285	50.19	15.69	33.36	.....	.76	1,700
Do	2452	34.55	9.80	55.13	.....	.52	2,505
Native cow	2258	60.79	17.51	20.82	.....	.88	1,205
Do	2324	48.66	14.98	35.65	.....	.71	1,785
Colorado	2212	53.19	14.69	31.35	.....	.77	1,595
Do	2270	53.94	15.01	30.27	.....	.78	1,560
Do	2306	57.57	16.58	24.97	.....	.88	1,365
Texas	2192	74.50	8.64	16.44	.....	.42	850
Do	2234	62.37	17.78	19.01	.....	.84	1,130
Do	2490	68.71	19.75	10.61	.....	.93	815
Rib roll:							
Native	2182	52.36	16.33	30.46	.....	.85	1,595
Do	2283	64.71	19.04	15.31	.....	.94	1,000
Do	2450	50.50	16.58	32.14	.....	.78	1,665
Native cow	2256	74.00	19.60	5.44	.....	.96	595
Do	2322	60.72	18.02	20.37	.....	.89	1,195
Colorado	2213	64.73	18.73	15.69	.....	.85	1,010
Do	2268	65.65	18.08	15.36	.....	.91	985
Do	2304	69.15	19.93	9.95	.....	.97	790
Texas	2193	67.28	18.49	13.33	.....	.90	905
Do	2235	70.48	20.14	8.41	.....	.97	730
Do	2438	73.29	21.10	4.64	.....	.97	590

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
FRESH BEEF—continued.							
Rib trimmings:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Native	2183	45.89	13.56	39.85	.....	0.70	1,935
Do	2284	52.32	16.13	30.73	.....	.82	1,595
Do	2451	33.89	10.64	54.93	.....	.54	2,515
Native cow	2257	61.74	18.06	19.33	.....	.87	1,150
Do	2323	49.20	14.64	35.42	.....	.74	1,765
Colorado	2214	49.26	14.33	35.74	.....	.67	1,775
Do	2269	61.17	16.94	21.02	.....	.87	1,200
Do	2305	55.28	16.11	27.79	.....	.82	1,475
Texas	2194	58.72	17.80	22.65	.....	.83	1,290
Do	2236	62.87	18.31	17.92	.....	.90	1,095
Do	2489	71.63	20.91	6.50	.....	.96	665
Loin:							
Native	2186	59.19	18.14	21.58	.....	1.09	1,245
Native cow	2259	66.04	18.45	14.47	.....	1.04	955
Colorado	2217	59.08	17.39	22.68	.....	.85	1,280
Do	2307	64.71	17.69	16.64	.....	.96	1,030
Texas	2197	59.90	17.33	21.91	.....	.83	1,245
Loin, boneless strip:							
Native	2455	50.89	16	32.37	.....	.74	1,665
Native cow	2273	55.58	22.71	20.55	.....	1.16	1,285
Do	2327	53.55	16.85	28.81	.....	.79	1,530
Colorado	2288	60.51	19.31	19.22	.....	.96	1,170
Texas	2242	66.33	20.52	12.17	.....	.98	895
Do	2493	77.25	17.96	3.96	.....	.83	500
Loin, trimmings:							
Native	2456	45.80	14.76	38.67	.....	.77	1,905
Native cow	2274	54.51	15.95	28.67	.....	.87	1,505
Do	2328	48.91	14.38	35.98	.....	.73	1,785
Colorado	2289	48.50	14.50	36.22	.....	.78	1,795
Texas	2239	66.66	18.81	13.61	.....	.92	925
Do	2494	65.32	18.77	15.01	.....	.90	985
Loin, tenderloin:							
Native	2453	53.44	16.93	28.80	.....	.83	1,530
Native cow	2271	66.51	11.28	21.62	.....	.59	1,120
Do	2325	54.17	15.06	29.95	.....	.82	1,445
Colorado	2286	54.26	15.93	29.01	.....	.80	1,520
Texas	2240	64.21	17.60	17.24	.....	.95	1,055
Do	2491	62.62	16.72	19.79	.....	.87	1,145
Loin, sirloin butt:							
Native	2454	51.60	16.57	31.04	.....	.79	1,615
Native cow	2272	63.73	20.51	14.66	.....	1.10	995
Do	2326	58.64	17.07	23.45	.....	.84	1,310
Colorado	2287	60.34	18.90	19.82	.....	.94	1,190
Texas	2241	68.51	19.77	10.70	.....	1.02	820
Do	2492	72.11	20.48	6.41	.....	1.00	650
Rump:							
Native	2187	49.92	15.74	33.57	.....	.77	1,710
Do	2292	48.05	14.75	36.39	.....	.81	1,810
Do	2459	45.16	14.72	39.41	.....	.71	1,940
Native cow	2262	60.92	17.85	20.33	.....	.90	1,190
Do	2331	49.07	14.48	35.77	.....	.68	1,780
Colorado	2218	55.32	15.88	27.98	.....	.82	1,475
Do	2277	59	17.51	22.55	.....	.94	1,275
Do	2310	56.07	16.48	26.58	.....	.87	1,430
Texas	2198	53.82	15.76	29.61	.....	.81	1,545
Do	2243	58.25	17.06	23.84	.....	.85	1,325
Do	2497	68.35	20.21	10.47	.....	.97	820
Round:							
Native	2188	63.09	19.64	16.30	.....	.97	1,055
Do	2293	64.90	19.28	14.87	.....	.95	985
Do	2460	56.85	17.63	24.66	.....	.86	1,370
Native cow	2263	69.68	19.95	9.36	.....	1.01	765
Do	2332	65.11	19.36	14.59	.....	.94	975
Colorado	2219	64.83	18.94	15.30	.....	.93	1,000
Do	2278	67.83	19.24	11.94	.....	.99	860
Do	2311	69.06	19.98	9.95	.....	1.01	790
Texas	2199	67.90	19.07	12.09	.....	.94	865
Do	2244	69.08	20.17	9.75	.....	1.00	790
Do	2498	74.29	22	2.67	.....	1.04	525
Flank:							
Native	2189	54.18	17.39	27.60	.....	.83	1,485
Do	2290	57.41	17.38	24.35	.....	.86	1,350
Do	2457	41.93	13.57	43.83	.....	.67	2,100
Native cow	2260	66.62	19.98	12.39	.....	1.01	895
Do	2329	54.84	17.14	27.21	.....	.81	1,465
Colorado	2220	53.53	15.43	30.24	.....	.80	1,560
Do	2275	60.21	18.09	20.85	.....	.85	1,215
Do	2308	62.19	18.21	18.68	.....	.91	1,130
Texas	2200	59.35	17.77	22.06	.....	.82	1,265
Do	2245	66.00	19.37	13.70	.....	.93	940
Do	2495	69.62	21.19	8.28	.....	.91	745

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
FRESH BEEF—continued.							
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Hind shank:							
Native	2190	67.71	20.58	10.81	.....	0.90	840
Do	2294	67.10	19.59	12.38	.....	.93	885
Do	2461	61.44	18.94	18.75	.....	.87	1,145
Native cow	2264	69.52	19.93	9.62	.....	.93	775
Do	2333	68.91	20.02	10.13	.....	.94	800
Colorado	2221	65.25	18.52	15.42	.....	.81	995
Do	2279	71.29	20.46	7.28	.....	.97	685
Do	2312	68.04	20.44	10.57	.....	.95	825
Texas	2201	72.77	21.38	4.92	.....	.93	605
Do	2246	73.58	21.06	4.34	.....	1.02	575
Do	2499	73.11	21.61	4.32	.....	.96	585
Tallow:							
Native	2291	10.01	1.60	88.18	.....	.21	3,750
Do	2458	8.24	2.68	88.92	.....	.16	3,800
Native cow	2261	16.15	5.04	78.58	.....	.28	3,405
Do	2330	21.85	6.92	70.83	.....	.40	3,115
Colorado	2276	17.40	6.14	76.18	.....	.28	3,325
Do	2309	9.65	3.78	86.31	.....	.26	3,715
Texas	2496	21.80	7.14	70.72	.....	.34	3,115
Heart	2462	68.75	15.78	14.60	.....	.87	910
Kidney	2469	75.72	16.06	7.10	.....	1.12	600
Lungs	2463	79.69	16.16	3.18	.....	.97	435
Liver	2468	69.91	21.34	5.68	1.72	1.35	670
Sweetbread	2470	70.92	15.36	12.13	.....	1.59	795
PICKLED BEEF, ETC.							
Extra India mess	2147	31.76	10.57	48.70	.....	8.97	2,250
Do	2179	42.44	13.32	40.13	.....	4.11	1,940
Spiced roll	2146	30.03	11.81	51.35	.....	6.81	2,390
Extra family	2176	36.95	11.83	47.22	.....	4	2,210
Plate	2177	40.12	13.34	41.86	.....	4.68	2,015
Sweet pickle tongue	2153	73.56	7.93	15.35	.....	8.16	795
Do	2178	50.88	17.03	25.82	.....	6.27	1,405
Tripe (Packers Premium Honeycomb)	2225	91.09	7.15	1.17	.47	.12	190
SALTED, DRIED, AND SMOKED BEEF.							
Smoked	2142	55	26.27	8.17	.....	10.56	835
Do	2143	57.66	27.98	6.25	.....	8.11	785
Dried knuckle	2173	56.67	26.05	7.56	.....	9.72	805
Dried salted, Uruguay	2175	30.67	46.85	5.58	.....	16.90	1,110
Sun dried, Mexico	2123	14.34	47.04	31.39	.....	7.23	2,200
Do	2124	24.27	47.01	11.84	.....	16.88	1,370
BEEF, CANNED.							
Corned beef	2059	43.24	19.58	31.08	.....	6.10	1,675
Do	2060	45.12	34.24	13.35	.....	7.29	1,200
Corned beef (Ramornie)	2085	51.78	26.27	19.91	.....	2.04	1,330
Corned beef (Rex)	2108	54.09	26.39	15.75	.....	3.77	1,155
Corned beef	2116	56.52	27.60	12.04	.....	3.84	1,020
Corned beef (Helmet)	2160	49.74	25.22	20.99	.....	4.05	1,355
Corned brisket	2106	53.21	22.72	21.82	.....	2.25	1,340
Boiled beef (Ramornie)	2086	51.82	24.36	22.54	.....	1.28	1,405
Luncheon beef (Helmet)	2161	52.93	26.44	15.88	.....	4.75	1,160
Pressed beef (White Label)	2157	45.72	21.09	29.20	.....	3.99	1,625
Roast beef (Ramornie)	2092	55.76	19.29	23.68	.....	1.27	1,360
Roast beef (Rex)	2095	57.62	25.92	15.23	.....	1.20	1,125
Roast beef	2115	62.83	24.77	11.20	.....	1.20	935
Do	2158	59.57	30.03	8.97	.....	1.43	910
Rump steak (Ramornie)	2093	56.30	23.51	18.66	.....	1.53	1,225
Dried beef (Rex)	2100	44.16	37.17	6.06	.....	12.61	950
Dried beef	2111	45.35	40.07	4.77	.....	9.81	945
Ox palates	2058	69.61	19.04	9.35	.....	2	750
Ox palates (Ramornie)	2091	73.16	15.85	10.57	.....	.42	740
Ox tail (Rex)	2097	67.90	24.55	6.34	.....	1.21	725
Ox cheek (Ramornie)	2061	66.07	22.35	8.36	.....	3.22	770
Ox tongue	2057	42.37	18.62	32.72	.....	6.29	1,725
Ox tongue (Ramornie)	2062	52.26	22.41	22.38	.....	2.95	1,360
Ox tongue (Rex)	2094	57.44	22.97	15.68	.....	3.91	1,090
Ox tongue	2112	50.76	21.69	23.62	.....	3.93	1,400
Ox tongue (Helmet)	2156	53.60	21.89	21.48	.....	3.03	1,315
Tongue, lunch (Rex)	2096	54.93	20.34	21.86	.....	2.87	1,300
Tongue, lunch	2113	53	20.96	22.51	.....	3.53	1,340
Tongue, lunch (Helmet)	2159	52.09	21.24	21.56	.....	5.11	1,305
Tongue, lunch (Rex, potted)	2110	47.91	20.78	26.70	.....	4.61	1,515
Do	2117	48.87	22.82	25	.....	3.31	1,480
Tongue, sandwich	2042	42.46	20.19	32.59	.....	4.76	1,750

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
BEEF, CANNED—continued.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Compressed brawn	2082	53.64	28.52	12.94	.....	4.90	1,075
Jellied brawn (White Label)	2162	44.25	18.24	33.22	.....	4.29	1,740
Kidneys (Ramornie)	2089	70.95	22.10	4.87	.....	2.08	615
Kidneys (Rex)	2104	72.87	14.64	5.40	4.25	2.84	580
Sweetbread (Rex)	2098	69.02	19.53	9.50	.....	1.95	765
Tripe (Ramornie)	2088	68.91	16.16	14.56	.....	.37	915
Tripe	2114	80.23	16.55	2.63	.....	.59	420
Chili con carne	2102	75.40	13.30	4.58	4.04	2.68	515
Minced collops (Rex)	2101	72.28	17.87	6.86	1.09	1.90	645
Condensed minced meat	2087	20.87	14.59	.78	56.68	7.08	1,360
VEAL.							
Neck:							
Native	2349	75.76	18.97	4.32	.....	.95	535
Do	2358	70.58	19.91	8.49	.....	1.02	730
Do	2391	71.39	19.93	7.62	.....	1.06	690
Texas	2334	74.88	19.39	4.70	.....	1.03	560
Do	2374	69.67	19.99	9.24	.....	1.10	760
Do	2419	78.38	18.69	6.92	.....	1.01	640
Chuck:							
Native	2350	74.30	18.77	5.90	.....	1.03	600
Do	2359	73.21	20.59	5.16	.....	1.04	600
Do	2392	71.55	19.24	8.16	.....	1.05	700
Texas	2335	75.37	18.48	5.13	.....	1.02	560
Do	2375	73.37	19.63	5.96	.....	1.04	615
Do	2420	72.33	18.19	8.50	.....	.98	700
Foreshank:							
Native	2351	74.44	20	4.54	.....	1.02	565
Do	2360	73.77	20.57	4.63	.....	1.03	575
Do	2393	73.55	20.11	5.31	.....	1.03	600
Texas	2336	75.77	19.14	4.09	.....	1	525
Do	2376	72.54	20.07	6.37	.....	1.02	640
Do	2421	73.95	18.95	6.14	.....	.96	610
Rib:							
Native	2352	74.08	20.34	4.52	.....	1.06	570
Do	2361	70.77	20.71	7.48	.....	1.04	700
Do	2394	70.36	20.03	8.59	.....	1.02	735
Texas	2337	75.48	19.22	4.25	.....	1.05	540
Do	2377	72.22	20.13	6.58	.....	1.07	650
Do	2422	70.49	19.21	9.31	.....	.99	750
Breast:							
Native	2353	68.39	18.62	12.01	.....	.98	850
Do	2362	66.69	19.42	12.87	.....	1.02	905
Do	2395	66.12	19.16	13.74	.....	.98	935
Texas	2338	72.18	18.79	8.06	.....	.97	690
Do	2378	65.07	18.72	15.24	.....	.97	990
Do	2423	65.41	18.20	15.44	.....	.95	990
Loin:							
Native	2354	69.56	19.20	10.19	.....	1.05	785
Do	2363	68.85	20.02	10.07	.....	1.06	850
Do	2396	68.50	19.61	10.82	.....	1.07	820
Texas	2339	72.22	20.34	6.48	.....	.96	690
Do	2379	69.47	19.27	10.24	.....	1.02	790
Do	2424	69.73	18.82	10.49	.....	.96	795
Leg:							
Native	2356	71.36	20.42	7.13	.....	1.09	680
Do	2365	71.35	20.57	7.01	.....	1.07	675
Do	2398	68.91	19.40	10.66	.....	1.03	810
Texas	2341	74.58	19.35	5.02	.....	1.05	570
Do	2381	72.16	20.07	6.68	.....	1.09	655
Do	2426	70.86	20.26	7.80	.....	1.08	705
Flank:							
Native	2355	64.36	18.88	15.83	.....	.93	1,020
Do	2364	69.01	21.05	8.86	.....	1.08	765
Do	2397	56.96	18.00	24.18	.....	.86	1,355
Texas	2340	72.71	18.52	7.74	.....	1.03	670
Do	2380	69.20	20.56	9.26	.....	.98	775
Do	2425	69.11	19.41	10.52	.....	.96	805
Hind shank:							
Native	2357	73.99	20.34	4.65	.....	1.02	575
Do	2366	73.39	20.95	4.58	.....	1.08	585
Do	2399	75.46	20.51	2.99	.....	1.04	510
Texas	2342	76.27	19.07	3.66	.....	1.00	510
Do	2382	73.74	20.39	4.83	.....	1.04	580
Do	2427	74.46	17.90	6.70	.....	.94	615
Heart	2429	73.20	16.21	9.63	.....	.96	705
Lungs	2431	76.77	17.07	5.05	.....	1.11	535
Liver	2430	73.70	19.58	3.99	1.42	1.31	560
Kidney	2471	74.71	16.58	7.45	.....	1.26	625

TABLE A.—Composition of food materials collected at the World's Fair—Continued.

	Laboratory No.	Water	Albuminoids	Fat	Carbohydrates	Ash	Fuel value per pound
MUTTON.							
Neck.		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Calories.
Native	[illegible]	[illegible]	[illegible]	[illegible]	.....	0.87	1,[illegible]0
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.83	1,300
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.91	1,315
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.86	1,410
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	1.08	1,110
Native lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	.78	2,090
Western	[illegible]	[illegible]	[illegible]	[illegible]	.....	.89	1,[illegible]0
Western lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	.80	1,525
Chuck.							
Native	[illegible]	[illegible]	[illegible]	[illegible]	.....	.93	1,400
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.70	1,705
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.78	1,815
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.67	2,040
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.74	1,735
Native lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	.63	2,710
Western	[illegible]	[illegible]	[illegible]	[illegible]	.....	.77	1,890
Western lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	1.22	1,650
Forest cutter.							
Native	[illegible]	[illegible]	[illegible]	[illegible]	.....	.86	1,130
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.93	1,140
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.77	1,575
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.95	895
Native lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	.84	1,785
Western	[illegible]	[illegible]	[illegible]	[illegible]	.....	.88	1,320
Western lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	.89	1,100
Loin.							
Native	[illegible]	[illegible]	[illegible]	[illegible]	.....	.83	1,440
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.74	1,805
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.79	1,830
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.73	1,995
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.83	1,725
Native lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	.51	2,660
Western	[illegible]	[illegible]	[illegible]	[illegible]	.....	.86	1,835
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.79	1,560
Flank.							
Native	[illegible]	[illegible]	[illegible]	[illegible]	.....	.76	1,650
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.62	2,075
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.80	1,835
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.59	2,530
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.76	1,950
Native lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	.62	2,915
Western	[illegible]	[illegible]	[illegible]	[illegible]	.....	.81	1,765
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.72	1,890
Hind leg.							
Native	[illegible]	[illegible]	[illegible]	[illegible]	.....	.96	990
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.92	935
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	1.18	905
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.94	1,155
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.97	1,020
Native lamb	[illegible]	[illegible]	[illegible]	[illegible]	.....	.89	1,465
Western	[illegible]	[illegible]	[illegible]	[illegible]	.....	.97	960
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.99	860
Tallow.							
Native	[illegible]	[illegible]	[illegible]	[illegible]	.....	.14	3,645
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.12	4,025
Liver	[illegible]	[illegible]	[illegible]	[illegible]	2.07	1.37	645
Heart	[illegible]	[illegible]	[illegible]	[illegible]	.....	.92	790
Kidney	[illegible]	[illegible]	[illegible]	[illegible]	.....	1.29	450
Lungs	[illegible]	[illegible]	[illegible]	[illegible]	.....	1.19	470
PICKLED.							
Tongue (spiced and cooked)	[illegible]	67.42	14.31	17.74	.....	.53	1,015
CANNED.							
Corned	[illegible]	[illegible]	[illegible]	[illegible]	.....	4.17	1,470
Tongue	[illegible]	[illegible]	[illegible]	[illegible]	.....	4.83	1,450
FRESH PORK.							
Head	[illegible]	[illegible]	[illegible]	[illegible]	.....	.76	1,720
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.56	2,330
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.66	1,895
Shoulder	[illegible]	[illegible]	[illegible]	[illegible]	.....	.92	1,095
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.84	1,480
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.71	1,600
Shoulder cut	[illegible]	[illegible]	[illegible]	[illegible]	.....	.81	1,660
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.71	2,020
Do	[illegible]	[illegible]	[illegible]	[illegible]	.....	.63	1,950

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
FRESH PORK—continued.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Tenderloin	2412	66.39	20.25	12.33	.....	1.03	895
Do	2440	62.38	19.50	17.14	.....	.98	1,085
Do	2478	66.24	18.84	13.91	.....	1.01	935
Ham	2413	62.89	18.29	17.89	.....	.93	1,095
Do	2441	67.63	19.28	12.08	.....	1.01	870
Do	2479	62.82	17.72	18.52	.....	.94	1,110
Flank cut	2411	60.45	18.29	20.30	.....	.96	1,195
Do	2439	60.74	18.85	19.45	.....	.96	1,175
Do	2477	56.03	16.18	26.94	.....	.85	1,430
Middle cut	2410	49.16	16.18	34.87	.....	.79	1,755
Do	2438	46.01	14.53	38.77	.....	.69	1,905
Do	2476	49.38	14.69	35.15	.....	.78	1,760
Belly fat	2416	13.65	4.59	81.52	.....	.24	3,525
Do	2444	10.99	3.23	85.57	.....	.21	3,670
Do	2482	16.64	4.52	78.62	.....	.22	3,400
Back fat	2415	6.92	2.25	90.68	.....	.15	3,870
Do	2443	5.53	1.95	92.43	.....	.09	3,935
Do	2481	10.49	2.69	86.67	.....	.15	.....
Ham fat	2417	8.80	3.32	87.72	.....	.16	3,760
Do	2445	8.28	2.30	89.26	.....	.16	3,810
Do	2483	10.15	2.54	87.17	.....	.14	3,725
Jowl fat	2414	13.52	5.08	81.21	.....	.19	3,525
Do	2442	13.35	4.30	82.16	.....	.19	3,569
Do	2480	21.23	5.66	72.80	.....	.31	2,180
Leaf lard	2418	4.61	1.13	94.15	.....	.11	3,990
Do	2446	3.13	.93	95.85	.....	.09	4,065
Do	2484	6.61	1.29	91.99	.....	.11	3,905
Heart	2432	75.63	17.05	6.35	.....	.97	585
Liver	2433	71.44	21.31	4.49	1.38	1.38	610
Lungs	2434	83.33	11.77	4.04	.....	.86	390
Kidney	2467	79.48	15.22	4.12	.....	1.18	455
PORK, PICKLED.							
Pork (lean ends)	2145	22.19	9.38	62.31	.....	6.12	2,800
Do	2500	18.64	6.66	69.25	.....	5.45	3,045
Do	2226	8.40	.56	88.41	.....	2.63	3,740
Short-cut mess	2502	20.36	6.60	66.99	.....	6.05	2,950
Franklin short-cut clear	2501	20.21	6.65	69.80	.....	5.34	3,170
Clear back	2151	11.19	1.49	83.37	.....	3.95	3,550
Pigs' feet (spiced)	2224	74.67	12.87	11.53	.....	.93	725
Tongue (sweet pickled tongue)	2152	51.81	18.40	23.12	.....	6.67	1,315
Tongue (spiced and cooked tongue)	2222	65.34	17.63	16.50	.....	.53	1,025
DRY SALTED.							
Clear belly	2148	18.07	6.79	71.48	.....	3.66	3,150
Rib	2149	17.22	6.66	72.87	.....	3.25	3,200
Polished backs	2066	17.54	8.62	71.62	.....	2.22	3,180
Dry salt clear back	2150	16.97	5.69	63.81	.....	3.53	3,220
SALTED AND SMOKED.							
Bacon	2069	20.38	9.32	66.78	.....	3.52	2,995
Do	2075	14.18	10.13	70.11	.....	5.58	3,145
Do	2140	17.34	8.96	71.20	.....	2.49	3,170
Do	2141	23.73	13.33	60.22	.....	2.72	2,790
Bacon (Supreme)	2204	26.85	11.50	57.45	.....	4.20	2,640
Do	2205	26.58	11.41	57.67	.....	4.34	2,645
Bacon, Breakfast	2125	10.26	13.29	71.52	.....	4.93	3,265
Bacon, Premium Boneless	2172	32.72	16.44	45.15	.....	5.69	2,210
Shoulder	2072	43.88	14.58	34.97	.....	6.57	1,750
Shoulder (California Ham)	2076	41.50	16.51	33.75	.....	8.24	1,730
Shoulder, New York	2074	30.44	14.92	48.96	.....	5.68	2,345
Ham	2071	38.57	14.93	41.94	.....	4.56	2,045
Ham, Stafford Ham	2077	36.29	15.02	43.19	.....	5.50	2,100
Ham	2126	40.76	21.55	30.28	.....	7.41	1,680
Do	2139	41.86	16.06	37.58	.....	4.51	1,885
Do	2144	43.26	15.40	37.17	.....	4.17	1,855
Ham (Italian)	2155	35.45	15.61	43.64	.....	5.30	2,130
Ham (Premium)	2174	37.17	12.42	44.68	.....	5.43	2,115
Ham (Supreme)	2202	45.66	13.91	36.96	.....	3.47	1,820
Ham	2203	40.37	11.83	44.73	.....	3.07	2,105
Raw pressed ham	2068	55.90	19.41	17.30	.....	7.39	1,090
Luncheon ham (cooked)	2067	47.81	22.80	22.68	.....	6.71	1,385
New England cooked ham	2133	50.19	25.15	19.36	.....	5	1,385
Boneless ham	2168	40.33	14.20	38.86	.....	6.61	1,905

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
MUTTON.							
Neck:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Native	2206	59.69	17.21	22.23	.....	0.87	1,260
Do	2247	59.48	15.93	23.76	.....	.83	1,300
Do	2313	58.79	16.39	23.91	.....	.91	1,315
Do	2367	55.86	17.60	25.68	.....	.86	1,410
Do	2400	61.85	19.25	17.82	.....	1.08	1,110
Native (ewe)	2227	42.08	13.65	43.49	.....	.78	2,090
Western	2295	59.13	17.04	22.94	.....	.89	1,280
Western (ewe)	2343	54.68	14.96	29.56	.....	.80	1,525
Chuck:							
Native	2207	56.68	16.44	25.95	.....	.93	1,400
Do	2249	51.27	13.66	34.37	.....	.70	1,705
Do	2315	47.95	14.64	36.63	.....	.78	1,815
Do	2369	43.52	13.32	42.49	.....	.67	2,040
Do	2402	50.01	14.59	34.66	.....	.74	1,735
Native (ewe)	2229	29.87	9.42	60.08	.....	.63	2,710
Western	2297	46.94	13.51	38.78	.....	.77	1,890
Western (ewe)	2345	51.66	14.32	32.80	.....	1.22	1,650
Fore shoulder:							
Native	2248	63.06	16.70	19.38	.....	.86	1,130
Do	2314	62.16	17.65	19.26	.....	.93	1,140
Do	2368	52.99	15.90	30.34	.....	.77	1,575
Do	2401	67.21	18.94	12.90	.....	.95	895
Native (ewe)	2228	48.38	15.20	35.58	.....	.84	1,785
Western	2296	59.01	15.80	24.31	.....	.88	1,320
Western (ewe)	2344	63.33	17.29	18.49	.....	.89	1,100
Loin:							
Native	2208	55.90	16.50	26.77	.....	.83	1,440
Do	2250	48.47	14.24	36.55	.....	.74	1,805
Do	2316	47.30	15.33	36.58	.....	.79	1,830
Do	2370	43.77	14.63	40.87	.....	.73	1,995
Do	2403	49.86	15.05	34.26	.....	.83	1,725
Native (ewe)	2230	30.84	10.00	58.65	.....	.51	2,660
Western	2298	47.90	13.83	37.41	.....	.86	1,835
Do	2346	53.45	15.65	30.11	.....	.79	1,560
Flank:							
Native	2209	51.23	15.87	32.14	.....	.76	1,650
Do	2251	43.55	11.91	43.92	.....	.62	2,075
Do	2317	47.21	15.20	36.79	.....	.80	1,835
Do	2372	32.69	12.04	54.68	.....	.59	2,530
Do	2405	44.15	16.02	39.07	.....	.76	1,950
Native (ewe)	2231	25.04	9.48	64.86	.....	.62	2,915
Western	2299	49.42	14.18	35.59	.....	.81	1,765
Do	2347	46.15	14.94	38.19	.....	.72	1,890
Hind leg:							
Native	2210	65.28	18.32	15.44	.....	.96	990
Do	2252	67.23	17.32	14.53	.....	.92	935
Do	2318	66.59	19.20	13.03	.....	1.18	905
Do	2373	61.24	18.66	19.16	.....	.94	1,155
Do	2406	64.49	18.68	15.86	.....	.97	1,020
Native (ewe)	2232	54.99	16.95	27.17	.....	.89	1,465
Western	2300	66.11	18.12	14.80	.....	.97	960
Do	2348	68.29	18.49	12.23	.....	.99	860
Tallow:							
Native	2371	2.88	1.20	95.78	.....	.14	3,645
Do	2404	3.86	1.10	94.92	.....	.12	4,025
Liver	2465	69.86	21.99	4.71	2.07	1.37	645
Heart	2464	71.60	15.55	11.93	.....	.92	790
Kidney	2472	78.67	16.80	3.24	.....	1.29	450
Lungs	2466	77.13	18.82	2.86	.....	1.19	470
PICKLED.							
Tongue (spiced and cooked)	2223	67.42	14.31	17.74	.....	.53	1,015
CANNED.							
Corned	2083	45.77	27.25	22.81	.....	4.17	1,470
Tongue	2084	47.57	23.63	23.97	.....	4.83	1,450
FRESH PORK.							
Head	2407	50.49	14.25	34.50	.....	.76	1,720
Do	2435	38.37	10.50	50.57	.....	.56	2,330
Do	2473	47.03	13.35	38.96	.....	.66	1,895
Shoulder	2408	63.63	16.96	18.49	.....	.92	1,095
Do	2436	55.29	15.75	28.12	.....	.84	1,480
Do	2474	53.59	13.96	31.74	.....	.71	1,600
Shoulder cut	2409	51.67	14.51	33.01	.....	.81	1,660
Do	2437	44.05	13.17	42.07	.....	.71	2,020
Do	2475	46.53	11.98	40.86	.....	.63	1,950

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
FRESH PORK—continued.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Tenderloin	2412	66.39	20.25	12.33	.....	1.03	895
Do	2440	62.38	19.50	17.14	.....	.98	1,085
Do	2478	66.24	18.84	13.91	.....	1.01	985
Ham	2413	62.89	18.29	17.89	.....	.93	1,095
Do	2441	67.63	19.28	12.08	.....	1.01	870
Do	2479	62.82	17.72	18.52	.....	.94	1,110
Flank cut	2411	60.45	18.29	20.30	.....	.96	1,195
Do	2439	60.74	18.85	19.45	.....	.96	1,175
Do	2477	56.03	16.18	26.94	.....	.85	1,430
Middle cut	2410	49.16	15.18	34.87	.....	.79	1,755
Do	2438	46.01	14.53	38.77	.....	.69	1,905
Do	2476	49.38	14.69	35.15	.....	.78	1,760
Belly fat	2416	13.65	4.59	81.52	.....	.24	3,525
Do	2444	10.99	3.23	85.57	.....	.21	3,670
Do	2482	16.64	4.52	78.62	.....	.22	3,400
Back fat	2415	6.92	2.25	90.68	.....	.15	3,870
Do	2443	5.53	1.95	92.43	.....	.09	3,935
Do	2481	10.49	2.69	86.67	.....	.15	.....
Ham fat	2417	8.80	3.32	87.72	.....	.16	3,760
Do	2445	8.28	2.30	89.26	.....	.16	3,810
Do	2483	10.15	2.54	87.17	.....	.14	3,725
Jowl fat	2414	13.52	5.08	81.21	.....	.19	3,525
Do	2442	13.35	4.30	82.16	.....	.19	3,559
Do	2480	21.23	5.66	72.80	.....	.31	2,180
Leaf lard	2418	4.61	1.13	94.15	.....	.11	3,990
Do	2446	3.13	.93	95.85	.....	.09	4,065
Do	2484	6.61	1.29	91.99	.....	.11	3,905
Heart	2432	75.63	17.05	6.35	.....	.97	585
Liver	2433	71.44	21.31	4.49	1.38	1.38	610
Lungs	2434	83.33	11.77	4.04	.....	.86	390
Kidney	2467	79.48	15.22	4.12	.....	1.18	455
PORK, PICKLED.							
Pork (lean ends)	2145	22.19	9.38	62.31	.....	6.12	2,800
Do	2500	18.64	6.66	69.25	.....	5.45	3,045
Do	2226	8.40	.56	88.41	.....	2.63	3,740
Short-cut mess	2502	20.36	6.60	66.99	.....	6.05	2,950
Franklin short-cut clear	2501	20.21	6.65	69.80	.....	5.34	3,170
Clear back	2151	11.19	1.49	83.37	.....	3.95	3,550
Pigs' feet (spiced)	2224	74.67	12.87	11.53	.....	.93	725
Tongue (sweet pickled tongue)	2152	51.81	18.40	23.12	.....	6.67	1,315
Tongue (spiced and cooked tongue)	2222	65.34	17.63	16.50	.....	.53	1,025
DRY SALTED.							
Clear belly	2148	18.07	6.79	71.48	.....	3.66	3,150
Rib	2149	17.22	6.66	72.87	.....	3.25	3,200
Polished backs	2066	17.54	8.62	71.62	.....	2.22	3,180
Dry salt clear back	2150	16.97	5.69	63.81	.....	3.53	3,220
SALTED AND SMOKED.							
Bacon	2069	20.38	9.32	66.78	.....	3.52	2,995
Do	2075	14.18	10.13	70.11	.....	5.58	3,145
Do	2140	17.34	8.96	71.20	.....	2.49	3,170
Do	2141	23.73	13.33	60.22	.....	2.72	2,790
Bacon (Supreme)	2204	26.85	11.50	57.45	.....	4.20	2,640
Do	2205	26.58	11.41	57.67	.....	4.34	2,645
Bacon, Breakfast	2125	10.26	13.29	71.52	.....	4.93	3,265
Bacon, Premium Boneless	2172	32.72	16.44	45.15	.....	5.69	2,210
Shoulder	2072	43.88	14.58	34.97	.....	6.57	1,750
Shoulder (California Ham)	2076	41.50	16.51	33.75	.....	8.24	1,730
Shoulder, New York	2074	30.44	14.92	48.96	.....	5.68	2,345
Ham	2071	38.57	14.93	41.94	.....	4.56	2,045
Ham, Stafford Ham	2077	36.29	15.02	43.19	.....	5.50	2,100
Ham	2126	40.76	21.55	30.28	.....	7.41	1,680
Do	2139	41.86	16.05	37.58	.....	4.51	1,885
Do	2144	43.26	15.40	37.17	.....	4.17	1,855
Ham (Italian)	2155	35.45	15.61	43.64	.....	5.30	2,130
Ham (Premium)	2174	37.47	12.42	44.68	.....	5.43	2,115
Ham (Supreme)	2202	45.66	13.91	36.96	.....	3.47	1,820
Ham	2203	40.37	11.83	44.73	.....	3.07	2,105
Raw pressed ham	2068	55.90	19.41	17.30	.....	7.39	1,090
Luncheon ham (cooked)	2067	47.81	22.80	22.68	.....	6.71	1,385
New England cooked ham	2133	50.49	25.15	19.36	.....	5	1,385
Boneless ham	2168	40.33	14.20	38.86	.....	6.61	1,905

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
HEAD CHEESE.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Head cheese	2134	48.14	21.14	27.35	.....	3.37	1,550
CANNED.							
Boar's head (Rex Brand)	2099	60.10	17.81	19.26	.....	2.83	1,145
Deviled ham	2109	46.07	17.95	33.70	.....	2.28	1,755
Do	2118	47.34	20.54	29.45	.....	2.67	1,625
Galantine of boar's head	2163	50.51	20.70	25.01	.....	3.78	1,440
Potted ham	2119	49.37	18.70	29.49	.....	2.44	1,595
Sandwich ham	2041	38.37	18.29	38.91	.....	4.43	1,980
SAUSAGE.							
Arles	2078	17.19	24.89	50.64	.....	7.28	2,600
Banquet	2132	62.73	17.93	15.66	.....	3.68	995
Bologna	2070	61.36	19.25	14.20	.....	5.19	955
Do	2130	67.00	18.89	11.13	.....	2.98	820
Do	2136	53.45	20.74	21.92	.....	3.89	1,310
Bologna (Clinton)	2171	.....	.....	.....	.....	.....	.....
Boneless ham	2128	50.51	16.67	27.24	.....	5.58	1,460
Farmer's	2138	23.16	27.22	42.05	.....	7.57	2,280
Frankfort sausage	2073	53.85	20.79	14.80	2.45	8.11	1,060
Do	2127	63.76	17.90	15.23	.....	3.11	975
Do	2135	58.32	18.41	19.71	.....	3.56	1,175
Do	2169	58.64	21.77	16.39	.....	3.20	1,100
Holsteiner	2137	25.65	29.38	37.30	3.38	4.29	2,185
Lyons	2081	32.49	32.28	27.19	.....	8.04	1,750
Pork	2167	54.38	14.65	28.23	.....	2.74	1,460
Salama	2079	28.59	22.52	41.93	.....	6.96	2,190
Do	2154	32.41	22.67	37.78	.....	7.14	2,015
Summer	2080	25.02	22.82	44.90	.....	7.26	2,320
Do	2129	24.62	24.42	42.98	.....	7.98	2,255
Do	2170	19.97	26.65	45.72	.....	7.66	2,425
Tongue	2131	46.36	17.27	33.13	.....	3.24	1,725
CANNED SAUSAGE.							
Beef	2090	59.54	17.80	20.63	.....	2.03	1,200
Bologna	2107	58.76	18.03	19.02	.53	3.66	1,140
Frankfort (Rex Brand)	2103	72.68	14.62	9.87	.....	2.83	690
Mortadilla di Bologna	2120	42.59	23.22	27.79	.....	6.40	1,600
Oxford	2105	28.91	9.86	58.49	.62	2.12	2,665
Ramornie	2063	56.60	16.64	24.76	.....	2.00	1,355
POULTRY, ETC., CANNED.							
Plover	2165	57.65	22.39	10.21	7.62	2.13	990
Chicken (sandwich)	2044	46.93	20.50	30.03	.....	2.54	1,645
Quail	2166	66.87	21.83	7.98	1.76	1.56	775
Turkey (sandwich)	2043	47.41	20.70	29.17	.....	2.72	1,615
DAIRY PRODUCTS.							
Cheese (Lump of White Cheese)	2386	46.79	21.37	23.88	.88	7.08	1,425
SOUPS, CANNED.							
Bouillon soup	2027	96.60	1.71	.01	.32	1.36	40
Do	2051	96.54	2.36	.08	.15	.87	50
Chicken soup	2021	94.47	3.17	.21	1.24	.91	90
Do	2055	93.18	3.85	.02	1.72	1.23	105
Chicken gumbo soup	2028	91.70	2.97	.20	3.82	1.31	135
Do	2054	86.76	4.57	1.65	5.67	1.35	260
Consomme soup	2050	95.99	2.54	.02	.32	1.13	55
Cream of asparagus soup	2023	87.36	2.46	3.16	5.64	1.38	285
Cream of celery soup	2024	88.59	2.05	2.75	5.16	1.45	250
Cream of corn soup	2025	86.77	2.47	1.90	7.89	.97	275
Cream of green pea soup	2022	87.68	2.57	2.66	5.82	1.27	270
Green-turtle soup	2052	86.62	6.07	1.87	3.98	1.46	270
Julienne soup	2048	95.85	2.71	.02	.52	.90	60
Mock turtle soup	2020	90.82	5.87	.51	1.59	1.21	160
Do	2053	88.85	4.49	1.34	3.91	1.41	210
Mulligatawny soup	2026	91.26	3.31	.27	3.90	1.26	145
Do	2046	87.20	4.07	.01	7.61	1.11	217
Pea soup	2045	81.58	5.82	.01	11.09	1.50	.....
Tomato soup	2029	89.72	1.72	.87	6.01	1.68	.....
Do	2047	90.41	1.89	1.19	5.31	1.20	.....
Ox-tail soup	2019	89.44	3.86	.49	4.30	1.91	175
Do	2056	88.21	4.06	2.12	4.17	1.34	245
Vegetable soup	2049	95.66	2.91	.02	.51	.90	65

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

	Laboratory No.	Water.	Albuminoids.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
FISH, ETC.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Java red fish	2383	60.47	17.56	.71	3.19	18.07	415
Pickled fish from Turkish village	2385	50.77	13.89	15.99	.....	19.35	935
Tunny in oil (canned)	2040	51.30	23.80	20.00	.59	4.31	1,295
Sturgeon, dried	2032	50.55	32.19	9.62	.....	7.64	1,005
Sturgeon, spinal column	2033	17.72	59.82	.84	17.06	4.56	1,465
Sturgeon, isinglass	2034	19.00	77.46	1.58	.....	1.96	1,510
Scumbria in oil, mackerel (canned)	2036	58.25	21.96	14.14	1.57	4.08	1,035
Sterliad marinad (canned Lamprey)	2039	63.24	16.94	12.19	3.62	4.01	900
Pressed caviare	2035	38.12	30.01	19.68	7.56	4.63	1,590
Pilchard in tomatoes (canned)	2037	52.70	27.52	15.77	.....	4.01	1,180
Pickled minogy (canned)	2038	56.54	21.85	18.61	.....	3.00	1,190
VEGETABLE.							
Vermicelli	2001	11.45	7.94	3.60	71.48	5.53	1,630
Do	2002	11.40	8.88	3.36	70.51	5.85	1,620
Do	2003	11.38	9.63	1.99	70.16	6.84	1,570
Do	2004	12.34	7.88	2.50	71.61	5.67	1,585
Do	2005	9.68	13.81	5.18	66.69	4.64	1,585
Do	2006	11.93	9.38	.94	71.50	6.25	1,545
Do	2007	11.89	9.06	.95	72.43	5.67	1,555
Do	2009	12.24	8.00	3.41	70.23	6.12	1,600
Do	2011	10.01	16.44	3.04	69.74	.77	1,730
Do	2013	9.98	12.50	.46	76.53	.53	1,675
Do	2014	10.17	12.56	.82	75.85	.60	1,680
Do	2017	9.39	14.31	.34	75.35	.61	1,675
Do	2030	12.24	11.81	.84	69.88	5.23	1,555
Do	2031	11.94	8.00	2.42	71.71	5.93	1,585
Do	2122	9.42	12.94	.74	76.39	.51	1,690
Macaroni	2012	10.73	14.25	.04	74.41	.57	1,655
Do	2015	11.13	12.31	.68	75.38	.50	1,645
Do	2018	9.90	14.31	.16	75.07	.56	1,665
Do	2121	10.01	12.50	.33	76.69	.47	1,675
Flat macaroni	2008	12.32	7.88	1.63	71.19	6.98	1,540
Spaghetti	2016	10.04	11.75	.84	76.82	.55	1,680
Italian paste	2010	10.47	16.63	4.86	67.25	.79	1,770
Rice, boiled	2384	52.73	5.03	.06	41.90	.28	875

COMPOSITION OF SIDE OF COLORADO BEEF.

[Expressed in percentages.]

Portion taken for analysis.	Laboratory No.	Refuse.	Edible portion.	Edible portion.				
				Water.	Water-free substance.	Nutrients.		
						Protein.	Fat.	Mineral matters.
Neck	2301	29.2	70.8	44.33	26.47	13.02	12.81	0.64
Chuck	2302	16.9	83.1	55.80	27.30	16.13	10.41	.76
Fore shank	2303 2304	36.6	63.4	43.55	19.85	12.80	6.45	.60
Rib	2305	21.7	78.3	47.85	30.45	13.88	15.87	.70
Roll	2304	.....	100	69.15	30.85	19.93	9.95	.97
Trimmings	2305	32.5	67.5	37.33	30.17	10.87	18.75	.55
Plate	2306	14.8	85.2	49.05	36.15	14.13	21.27	.75
Loin	2307	17.1	82.9	53.65	29.25	14.65	13.79	.81
Flank, without tallow	2308	1.2	98.8	61.44	37.36	17.99	18.46	.91
Tallow	2309	.....	.....	9.65	90.35	3.78	86.31	.26
Rump	2310	27.1	72.9	40.88	32.02	12.01	19.38	.63
Round	2311	10	90	62.16	26.84	17.98	8.95	.91
Hind shank	2312	54.5	45.5	30.96	14.54	9.30	4.81	.43
Total (except kidney)	.....	18.64	81.36	51.96	29.41	14.96	13.71	.74
Without tallow	.....	18.88	81.12	52.50	28.62	15.11	12.76	.75

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

COMPOSITION OF SIDE OF COLORADO BEEF—Continued.

[Expressed in grams.]

Portion taken for analysis.	Laboratory No.	In whole specimen as taken for analysis.			Edible portion.			
		Total.	Refuse.	Edible portion.	Water.	Protein.	Fat.	Mineral matters.
Neck	2301	1,360	400	960	600	180	170	10
Chuck	2302	30,840	5,210	25,630	17,210	4,970	3,210	240
Fore shank	2303	12,930	4,730	8,200	5,630	1,660	830	80
	2304							
Rib	2305	13,040	2,830	10,210	6,240	1,810	2,070	90
Roll	2304	4,310	.....	4,310	2,980	860	430	40
Trimmings	2305	8,730	2,830	5,900	3,260	950	1,640	50
Plate	2306	20,860	3,090	17,770	10,230	2,950	4,440	150
Loin	2307	23,300	3,980	19,320	12,500	3,420	3,220	180
Flank, without tallow	2308	4,710	60	4,650	2,890	850	870	40
Tallow	2309	1,960	.....	1,960	190	70	1,690	10
Rump	2310	6,920	1,880	5,040	2,830	830	1,340	40
Round	2311	30,280	3,030	27,250	18,820	5,450	2,710	270
Hind shank	2312	5,670	3,090	2,580	1,760	530	270	20
		151,870	28,300	123,570	78,900	22,720	20,820	1,130
Kidney	.....	510						
		152,380						
Without tallow and kidney	.....	149,910	28,300	121,610	78,710	22,650	19,130	1,120

[Expressed in pounds.]

Neck	2301	3	0.88	2.12	1.32	0.40	0.38	0.02
Chuck	2302	68	11.50	56.50	37.94	10.96	7.07	.53
Fore shank	2303	28.50	10.44	18.06	12.40	3.66	1.83	.17
	2304							
Rib	2305	28.75	6.25	22.50	13.75	3.99	4.56	.20
Roll	2304	9.50	0.00	9.50	6.57	1.89	.95	.09
Trimmings	2305	19.25	6.25	13	7.18	2.10	3.61	.11
Plate	2306	46	6.81	39.19	22.56	6.51	9.79	.33
Loin	2307	51.37	8.81	42.56	27.55	7.53	7.09	.39
Flank, without tallow	2308	10.38	.13	10.25	6.37	1.87	1.92	.09
Tallow	2309	4.31	.....	4.31	.42	.15	3.72	.02
Rump	2310	15.25	4.13	11.12	6.24	1.83	2.96	.09
Round	2311	66.75	6.69	60.06	41.49	12.01	5.97	.59
Hind shank	2312	12.50	6.81	5.69	3.88	1.17	.60	.04
		334.81	62.45	272.36	173.92	50.08	45.89	2.47
Kidney	.....	1.13						
Total	.....	335.94						
Without tallow and kidney	.....	330.50	62.45	268.05	173.50	49.93	42.17	2.45

TABLE A.—*Composition of food materials collected at the World's Fair*—Continued.

COMPOSITION OF PRESERVED HAM AND SHOULDER OF PORK.

EDIBLE PORTION.

[Per cent.]

	Laboratory No.	Water.	Nutrients.			
			Total.	Protein.	Fat.	Mineral matters.
SALTED AND SMOKED.						
Ham	.....	41.49	58.51	16.68	39.09	2.74
Do	2071	38.57	61.43	14.93	41.94	4.56
Ham (Stafford)	2077	36.29	63.71	15.02	43.19	5.50
Ham	2126	40.76	59.24	21.55	30.28	7.41
Do	2139	41.86	58.14	16.05	37.58	4.51
Do	2144	43.26	56.74	15.40	37.17	4.17
Ham (Italian)	2155	35.45	64.55	15.61	43.64	5.30
Ham (Premium)	2174	37.47	62.53	12.42	44.68	5.43
Ham (Supreme)	2202	45.66	54.34	13.91	36.96	3.47
Ham	2203	40.37	59.63	11.83	44.73	3.07
Raw pressed ham	2068	55.90	44.10	19.41	17.30	7.39
Luncheon ham, cooked	2067	47.81	52.19	22.80	22.68	6.71
New England cooked ham	2133	50.49	49.51	25.15	19.36	5
Boneless ham	2168	40.33	59.67	14.20	38.86	6.61
Shoulder	2072	43.88	56.12	14.58	34.97	6.57
Shoulder (California Ham)	2076	41.50	58.50	16.51	33.75	8.24
Shoulder (New York)	2074	30.44	69.56	14.92	48.96	5.68

MATERIALS AS SOLD, INCLUDING BOTH EDIBLE PORTION AND REFUSE.

[Per cent.]

	Laboratory No.	Refuse.	Edible portion.				
			Edible portion.	Water.	Nutrients.		
					Protein.	Fat.	Mineral matters.
SALTED AND SMOKED.							
Ham	.....	11.4	88.6	36.77	14.77	34.63	2.43
Do	2071	10.7	89.3	34.44	13.33	37.46	4.07
Ham (Stafford)	2077	12.8	87.2	31.65	13.10	37.66	4.79
Ham	2126	19	81	33.02	17.46	24.52	6
Do	2139	10	90	37.67	14.45	33.82	4.06
Do	2144	12.2	87.8	37.98	13.52	32.64	3.66
Ham (Italian)	2155	22.1	77.9	27.62	12.16	34.49	4.13
Ham (Premium)	2174	13.4	86.6	32.45	10.75	38.69	4.71
Ham (Supreme)	2202	10.2	89.8	41	12.50	33.19	3.11
Ham	2203	10.7	89.3	36.05	10.57	39.94	2.74
Raw pressed ham	2068	2.2	97.8	54.67	18.99	16.92	7.22
Luncheon ham, cooked	2067	2.8	97.2	46.47	22.16	22.05	6.52
New England cooked ham	2133	1.5	98.5	49.73	24.77	19.07	4.93
Boneless ham	2168	5.6	94.4	38.08	13.40	36.68	6.24
Shoulder	2072	19.4	80.6	35.37	11.75	28.19	5.29
Shoulder (California Ham)	2076	17.4	82.6	34.28	13.64	27.87	6.81
Shoulder (New York)	2074	14.1	85.9	26.15	12.81	42.06	4.88

Percentages of nutrients (nutritive ingredients), water, and refuse, and estimated potential energy (fuel value) in specimens of food materials—Continued.

Food materials.	Refuse (bones, skin, shell, etc.).	Edible portion.						
		Water.	Nutrients.					Potential energy in 1 pound.
			Total.	Protein.	Fat.	Carbohydrates.	Mineral matters.	
ANIMAL FOODS, AS PURCHASED—continued.								
Pork—Continued.								
Salted and smoked:								
Bacon	4.5	19.4	76.1	8.9	63.8	.....	3.4	2,860
Do	7.5	13.1	79.4	9.4	64.8	.....	5.2	2,910
Do	9	15.8	75.2	8.2	64.8	.....	2.2	2,890
Do	9.5	21.5	69	12.1	54.5	.....	2.4	2,525
Bacon (Supreme)	8.2	24.6	67.2	10.6	52.7	.....	3.9	2,420
Do	6.9	24.8	68.3	10.6	53.7	.....	4	2,465
Bacon (Breakfast)	13	8.9	78.1	11.6	62.2	.....	4.3	2,840
Bacon (Premium Boneless)	9.6	29.6	60.8	14.9	40.8	.....	5.1	2,000
Ham	11.4	36.8	51.8	14.8	34.6	.....	2.4	1,735
Do	10.7	34.4	54.9	13.3	37.5	.....	4.1	1,830
Ham (Stafford)	12.8	31.6	55.6	13.1	37.7	.....	4.8	1,835
Ham	19	33	48	17.5	24.5	.....	6	1,360
Do	10	37.7	52.3	14.4	33.8	.....	4.1	1,895
Do	12.2	38	49.8	13.5	32.6	.....	3.7	1,625
Ham (Italian)	22.1	27.6	50.3	12.2	34	.....	4.1	1,665
Ham (Premium)	13.4	32.4	54.2	10.8	38.7	.....	4.7	1,835
Ham (Supreme)	10.2	41	48.8	12.5	33.2	.....	3.1	1,635
Ham	10.7	36.1	53.2	10.6	39.9	.....	2.7	1,880
Raw pressed ham	2.2	54.4	43.1	19	16.9	.....	7.2	1,065
Luncheon ham cooked	2.8	46.5	50.7	22.2	22	.....	6.5	1,340
New England cooked ham	1.5	49.7	48.8	24.8	19.1	.....	4.9	1,265
Boneless ham	5.6	38.1	56.3	13.4	36.7	.....	6.2	1,800
Shoulder	19.4	35.4	45.2	11.7	28.2	.....	5.3	1,405
Shoulder (California Ham)	17.4	34.3	48.3	13.6	27.9	.....	6.8	1,430
Shoulder (New York)	14.1	26.1	59.8	12.8	42.1	.....	4.9	2,015
Chicken	38.2	44.6	17.2	15.1	1.2	.....	.9	330
Turkey	32.4	44.7	22.9	16.1	5.9	.....	.9	550
Eggs, in shell	13.7	63.1	23.2	12.1	10.2	.....	.9	655
Fish, etc.								
Flounder, whole	66.8	27.2	6	5.2	.3	.....	.5	110
Bluefish, dressed	48.6	43	11.1	9.8	.6	.....	.7	210
Codfish, dressed	29.9	58.5	11.6	10.6	.2	.....	.8	205
Shad, whole	50.1	35.2	14.7	9.2	4.8	.....	.7	375
Mackerel, whole	44.8	40.4	15	10	4.3	.....	.7	365
Halibut, dressed	17.7	61.9	20.4	15.1	4.4	.....	.9	465
Salmon, whole	35.3	40.6	24.1	14.3	8.8	.....	1	635
Salt codfish	42.1	40.5	17.6	16	.4	.....	1.2	315
Smoked herring	50.9	19.2	29.9	20.2	8.8	.....	.9	745
Salt mackerel	40.4	28.1	31.5	14.7	15.1	.....	1.7	910
Canned salmon	4.9	59.3	35.8	19.3	15.3	.....	1.2	1,005
Lobsters	62.1	31	6.9	5.5	.7	0.1	.6	135
Oysters	82.3	15.4	2.3	1.1	.2	.6	.4	40
ANIMAL FOODS, EDIBLE PORTION.								
Beef.								
Neck	.....	62	38	19.5	17.5	.....	1	1,100
Shoulder	.....	63.9	36.1	19.5	15.6	.....	1	1,020
Chuck rib	.....	58	42	17.6	23.5	.....	.9	1,320
Rib	.....	48.1	51.9	15.4	35.6	.....	.9	1,790
Sirloin	.....	60	40	18.5	20.5	.....	1	1,210
Round	.....	68.2	31.8	20.5	10.1	.....	1.2	805
Side, without kidney fat	.....	54.8	45.2	17.2	27.1	.....	.9	1,465
Rump, corned	.....	58.1	41.9	13.3	26.6	.....	2	1,370
Flank, corned	.....	49.8	50.2	14.2	33	.....	3	1,655
Neck	.....	62.6	37.4	18.4	18.1	.....	.9	1,105
Chuck	.....	67.2	32.8	19.4	12.5	.....	.9	890
Fore shank	.....	68.7	31.3	20.2	10.2	.....	.9	805
Rib	.....	61.1	38.9	17.7	20.3	.....	.9	1,185
Plate	.....	57.6	42.4	16.5	25	.....	.9	1,360
Total fore quarter	.....	63.6	36.4	18.4	17.1	.....	.9	1,065
Loin	.....	64.7	35.3	17.7	16.6	.....	1	1,030
Flank	.....	62.2	37.8	18.2	18.7	.....	.9	1,130
Rump	.....	56.1	43.9	16.5	26.6	.....	.8	1,430
Round	.....	69.1	30.9	20	9.9	.....	1	790
Hind shank	.....	68	32	20.4	10.6	.....	1	825
Hind quarter without tallow	.....	66	34	18.8	14.3	.....	.9	955
Tallow	.....	9.7	90.3	3.8	86.3	.....	.2	3,715
Whole side	.....	63.9	36.1	18.4	16.8	.....	.9	1,050
Whole side without tallow	.....	64.8	35.2	18.6	15.7	.....	.9	1,010

Percentages of nutrients (nutritive ingredients), water, and refuse, and estimated potential energy (fuel value) in specimens of food materials—Continued.

Food materials.	Refuse (bones, skin, shell, etc.).	Edible portion.						
		Water.	Nutrients.					Potential energy in 1 pound.
			Total.	Protein.	Fat.	Carbohydrates.	Mineral matters.	
ANIMAL FOODS, EDIBLE PORTION—continued.								
Veal.								
Shoulder	.....	68.8	31.2	20.2	9.8	.....	1.2	790
Mutton.								
Shoulder	.....	58.6	41.4	18.1	22.4	.....	.9	1,280
Leg	.....	61.8	38.2	18.3	19	.....	.9	1,140
Loin	.....	49.3	50.7	15	35	.....	.7	1,755
Side, without kidney fat	.....	53.5	46.5	16.9	28.7	.....	.9	1,525
Pork.								
Shoulder roast, fresh	.....	50.3	49.7	16	32.8	.....	.9	1,680
Fat, salted	.....	12.1	87.9	.9	82.8	.....	4.2	3,510
Pork (lean ends)	.....	22.2	77.8	9.4	62.3	.....	6.1	2,805
Do	.....	18.6	81.4	6.7	69.3	.....	5.4	3,050
Do	.....	8.4	91.6	.6	88.4	.....	2.6	3,840
Short cut mess	.....	20.4	79.6	6.6	67	.....	6	2,950
Franklin short cut clear	.....	18.2	81.8	6.7	69.8	.....	5.3	3,070
Clear back	.....	11.2	88.8	1.5	83.4	.....	3.9	3,550
Dry salted:								
Clear belly	.....	18.1	81.9	6.8	71.5	.....	3.6	3,145
Rib	.....	17.2	82.8	6.7	72.9	.....	3.2	3,200
Polished backs	.....	17.6	82.4	8.6	71.6	.....	2.2	3,180
Dry salt clear back	.....	17	83	5.7	73.8	.....	3.5	3,220
Salted and smoked:								
Bacon	.....	20.4	79.6	9.3	66.8	.....	3.5	2,990
Do	.....	14.2	85.8	10.1	70.1	.....	5.6	3,145
Do	.....	17.4	82.6	8.9	71.2	.....	2.5	3,170
Do	.....	23.8	76.2	13.3	60.2	.....	2.7	2,785
Bacon (Supreme)	.....	26.8	73.2	11.5	57.5	.....	4.2	2,640
Do	.....	26.6	73.4	11.4	57.7	.....	4.3	2,645
Bacon (Breakfast)	.....	10.3	89.7	13.3	71.5	.....	4.9	3,265
Bacon (Premium Boneless)	.....	32.7	67.3	16.4	45.2	.....	5.7	2,210
Ham, salted, smoked	.....	41.5	58.5	16.7	39.1	.....	2.7	1,960
Ham	.....	38.6	61.4	14.9	41.9	.....	4.6	2,045
Ham (Stafford)	.....	36.3	63.7	15	43.2	.....	5.5	2,100
Ham	.....	40.8	59.2	21.5	30.8	.....	7.4	1,680
Do	.....	41.9	58.1	16	37.6	.....	4.5	1,885
Do	.....	43.3	56.7	15.4	37.2	.....	4.1	1,855
Ham (Italian)	.....	35.5	64.5	15.6	43.6	.....	5.3	2,130
Ham (Premium)	.....	37.5	62.5	12.4	44.7	.....	5.4	2,115
Ham (Supreme)	.....	45.6	54.4	13.9	37	.....	3.5	1,820
Ham	.....	40.4	59.6	11.8	44.7	.....	3.1	2,105
Raw pressed ham	.....	55.9	44.1	19.4	17.3	.....	7.4	1,090
Luncheon ham, cooked	.....	47.8	52.2	22.8	22.7	.....	6.7	1,380
New England cooked ham	.....	50.5	49.5	25.1	19.4	.....	5	1,285
Boneless ham	.....	40.3	59.7	14.2	38.9	.....	6.6	1,905
Shoulder	.....	43.9	56.1	14.6	35	.....	6.5	1,750
Shoulder (California Ham)	.....	41.5	58.5	16.5	33.8	.....	8.2	1,735
Shoulder (New York)	.....	30.4	69.6	14.9	49	.....	5.7	2,345
Sausage—								
Pork	.....	41.2	58.8	13.8	42.8	.....	2.2	2,005
Bologna	.....	62.4	37.6	18.8	15.8	.....	3	1,015
Chicken	.....	72.2	27.8	24.4	2	.....	1.4	540
Turkey	.....	66.2	33.8	23.9	8.7	.....	1.2	810
Eggs	.....	73.8	26.2	14.9	10.5	.....	.8	721
Milk	.....	87	13	3.6	4	4.7	.7	325
Butter	.....	10.5	89	1	85	.5	3	3,615
Oleomargarine	.....	11	89.5	.6	85	.4	3	3,605
Cheese:								
Full-cream	.....	30.2	69.8	28.3	35.5	1.8	4.2	2,070
Skim-milk	.....	41.3	58.7	38.4	6.8	8.9	4.6	1,165
Fish.								
Flounder	.....	84.2	15.8	13.8	.7	.....	1.3	285
Haddock	.....	81.7	18.3	16.8	.3	.....	1.2	325
Codfish	.....	82.6	17.4	15.8	.4	.....	1.2	310
Shad	.....	70.6	29.4	18.6	9.5	.....	1.3	745
Mackerel	.....	73.4	26.6	18.2	7.1	.....	1.3	640
Halibut	.....	75.4	24.6	18.3	5.2	.....	1.1	560
Salmon	.....	63.6	36.4	21.6	13.4	.....	1.4	965
Salt cod	.....	53.6	.....	21.4	.3	.....	1.6	410
Herring, salt	.....	34.6	.....	36.4	15.8	.....	1.5	1,345
Mackerel, salt	.....	43.4	.....	17.3	26.4	.....	2.6	1,860
Oysters	.....	87.1	12.9	6	1.2	3.7	2	230

Percentages of nutrients (nutritive ingredients), water, and refuse, and estimated potential energy (fuel value) in specimens of food materials—Continued.

Food materials	Refuse (bones, skin, shell, etc.).	Edible portion.						
		Water.	Nutrients.					Potential energy in 1 pound.
			Total.	Protein.	Fat.	Carbohydrates.	Mineral matters.	
ANIMAL FOOD, EDIBLE PORTION—continued.								
Vegetable foods.								
Wheat flour	.....	12.5	87.5	11	1.1	74.9	0.5	1,644
Graham flour (wheat)	.....	13.1	86.9	11.7	1.7	71.7	1.8	1,625
Rye flour	.....	13.1	86.9	6.7	.8	78.7	.7	1,625
Buckwheat flour	.....	14.6	85.4	6.9	1.4	76.1	1	1,605
Oatmeal	.....	7.6	92.4	15.1	7.1	68.2	2	1,850
Corn meal	.....	15	85	9.2	3.8	70.6	1.4	1,645
Rice	.....	12.4	87.6	7.4	.4	79.4	.4	1,630
Peas	.....	12.3	87.7	26.7	1.7	56.4	2.9	1,565
Beans	.....	12.6	87.4	23.1	2	59.2	3.1	1,615
Potatoes	.....	78.9	21.1	2.1	.1	17.9	1	375
Sweet potatoes	.....	71.1	28.9	1.5	.4	26	1	530
Turnips	.....	89.4	10.6	1.2	.2	8.2	1	185
Carrots	.....	88.6	11.4	1.1	.4	8.9	1	200
Onions	.....	87.6	12.4	1.4	.3	10.1	.6	225
String beans	.....	87.2	12.8	2.2	.4	9.4	.8	235
Green peas	.....	78.1	21.9	4.4	.6	16	.9	405
Green corn	.....	81.3	18.7	2.8	1.1	13.2	.6	345
Tomatoes	.....	96	4	.8	.4	2.5	.3	80
Cabbage	.....	91.9	8.1	2.1	.3	5.5	1.1	155
Apples	.....	83.2	16.8	.2	.4	15.9	.3	315
Sugar, granulated	.....	2	98	.....	.....	97.8	.2	1,820
Molasses	.....	24.6	75.4	.....	.....	73.1	2.3	1,360
White bread (wheat)	.....	32.3	67.7	8.8	1.7	56.3	.9	1,280
Boston crackers	.....	8.3	91.7	10.7	9.9	68.7	2.4	1,895

NUTRITIVE VALUES OF DIFFERENT FOOD MATERIALS.

The nutritive value of food depends mainly upon the amounts and proportions of actually nutritive materials which they contain. Of course the digestibility and the ways in which they "agree and disagree" with different people are important factors of the nutritive value. What we now have to consider is the chemical composition of food materials, the amounts of nutrients and energy which they contain.

Chemical composition of food materials.—Tables A and B in the appendix show the composition of specimens of food materials in common use. From those are taken the figures in Table 1 herewith.

These show the proportions of the nutritive ingredients, protein, fats, and carbohydrates, and their potential energy. A proper diet will contain sufficient protein to build up the tissues of the body and repair their wastes and sufficient energy to supply heat to keep the body warm and muscular power for its work. Since the protein and the energy are the chief factors of the nutritive value, the quantities are expressed in table.

The figures in these tables of composition and energy of food materials are based upon chemical analyses. For the larger number of materials American figures are used, but in a few cases where analyses of our food products are lacking European analyses are employed. The amounts of energy are calculated by assuming a certain number of calories for one one-hundredth of a pound of each of the nutrients.

TABLE 1.—*Nutritive ingredients and fuel values of food materials.*

[Amounts of nutrients and calories of energy in 1 pound.]

Food materials.	Nutrients,			Potential energy—fuel value.	Nutritive ratio.
	Protein.	Fats.	Carbohydrates.		
ANIMAL FOODS.					
Beef:	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*	*1:*
Neck	0.156	0.140	.....	880	2
Chuck rib	.150	.201	.....	1,125	3
Rib	.122	.279	.....	1,405	5.1
Shoulder	.170	.137	.....	895	1.8
Sirloin	.150	.164	.....	970	2.5
Rump	.137	.311	.....	1,570	5.1
Round	.180	.123	.....	855	1.5
Cooked, corned, and canned	.267	.171	.....	1,215	1.6
Liver	.201	.054	0.035	665	.8
Mutton:					
Shoulder	.151	.188	.....	1,075	2.9
Leg	.150	.156	.....	935	2.3
Loin	.126	.295	.....	1,480	5.3
Pork:					
Loin	.141	.253	.....	1,380	4
Smoked ham	.148	.346	.....	1,735	5.8
Fat, salt pork	.009	.828	.....	3,510	.....
Sausage	.122	.424	.013	2,040	7.9
Chicken	.151	.012	.....	330	.3
Turkey	.161	.059	.....	550	.9
Shad, whole	.092	.048	.....	375	1.2
Mackerel	.100	.043	.....	370	1
Bluefish, dressed	.098	.006	.....	205	.1
Haddock, dressed	.082	.002	.....	160	.1
Cod, dressed	.106	.002	.....	205	.05
Halibut steak	.151	.044	.....	465	.7
Dry salt cod	.160	.004	.....	315	.05
Salt mackerel	.147	.151	.....	910	2.4
Canned salmon	.209	.159	.....	975	1.7
Oysters "solids"	.063	.016	.040	260	1.2
Lobster, whole	.054	.007	.....	130	.3
Eggs	.149	.105	.....	720	1.6
Milk	.036	.040	.047	325	3.8
Butter	.010	.850	.005	3,615	.....
Cheese, full cream	.283	.355	.018	2,070	2.9
VEGETABLE FOODS.					
Potatoes	.019	.001	.161	325	8.6
Sweet potatoes	.013	.003	.234	475	18.5
Turnips	.011	.002	.074	165	7.1
Granulated sugar	.....	.....	.978	1,820	.....
Dried beans	.231	.020	.592	1,615	2.8
Corn meal (maize)	.092	.038	.706	1,645	8.6
Oatmeal	.147	.071	.684	1,845	5.7
Wheat flour	.110	.011	.749	1,645	7.2
Wheat bread	.088	.017	.563	1,280	6.8
Rice	.074	.004	.794	1,630	10.9

The last column in the table gives the nutritive ratio, which is the proportion of the protein to the sum of all the nutritive ingredients.* Materials with large proportions of fats or carbohydrates and little protein, like fat meats or potatoes, have a large, or, as it is often called, a "wide" nutritive ratio. Those with a large proportion of protein as compared with the carbohydrates and fats, like lean meat, codfish, and beans, have a small or "narrow" nutritive ratio. In other words, the materials rich in tissue-forming substances have a narrow and those with a large preponderance of fuel materials have a wide nutritive ratio. This is an important matter in the adjusting of food to the

*The fuel value of the fat is 2½ that of the protein and carbohydrates. In calculating the nutritive ratio the quantity of fats is multiplied by 2½. This product is added to the weight of the carbohydrates. The sum divided by the weight of the protein gives the nutritive ratio.

demands of the body. A well-balanced diet is one which has the right proportions of protein to the fats and carbohydrates. A relative excess of the tissue formers makes the ratio necessarily narrow, while an excess of the fuel ingredients makes an overwide ratio in the diet. Either of these errors is disadvantageous. Our food materials and our diet are apt to have too wide a nutritive ratio. In other words, we consume on the whole relatively too little protein and too much of carbohydrates and fats.

In considering the figures of Table 1 it must be remembered that many of our food materials, as they are bought in the market, include, along with the edible portions, more or less of what is called refuse, like the bone of meat, the shells of eggs, and skin of potatoes. Materials like milk, flour, and bread have no refuse. The figures in the table refer to the materials as we ordinarily find them, and allow for the refuse. The proportions of refuse may be seen in Table A of the appendix.

Another important consideration is the amount of water in the edible portion of the food, as may be also seen in Table A. In general, animal foods contain the most water and vegetable foods the most nutrients, though potatoes and turnips are exceptions, the former being three-fourths and the latter nine-tenths water. Butter, on the other hand, though one of the animal foods, has, on the average, about 9 per cent of water. The milk from which it is made is not far from seven-eighths water. Meats have less water in proportion as they have less fats, and vice versa. The fatter the meat the less the amount of water in it. Thus, very lean beef (the muscle of a lean animal from which the fat has been trimmed off) may have 78 per cent of water and only 22 per cent of nutrients. The rather fat sirloin may have two-fifths and very fat pork one-tenth or less of water. The flesh of fish is, in general, more watery than ordinary meats, that of salmon being five-eighths water, codfish over four-fifths, and flounder over six-sevenths. Flour and meal have but little water and sugar; when well dried, almost none.

In examining the proportions of individual nutrients, protein, fats, and carbohydrates, the most striking fact is the difference between the meats and fish on the one hand, and the vegetable foods on the other. The vegetable foods are rich in carbohydrates, like starch and sugar, while the meats have not enough to be worth mentioning. On the other hand, the meats abound in protein and fats, of which the vegetable foods usually have but little. Beans and oatmeal, however, are rich in protein, while fat pork has very little. In the first glance at a table like this people sometimes obtain a wrong impression. For instance, rice contains about seven-eighths and potatoes only one-fourth nutritive materials. The first inference is that rice is more than three times as nutritious as potatoes. In one sense this is true; that

is to say, a pound of rice contains more than three times as much nutrients as a pound of potatoes. But if we take enough of potatoes to furnish as much nutritive material as the pound of rice, the composition and nutritive value of the two will be just about the same. In cooking the rice we mix water with it, and may thus make a material not very different in composition from potatoes. By drying the potatoes they could be made very similar in composition and food value to rice. Taken as we find them, a pound of rice and 3½ pounds of potatoes would contain nearly equal weights of each class of nutrients and would have about the same nutritive value. The fats have, weight for weight, about two and one-fourth times the potential energy of either the protein or the carbohydrates. Water has no potential energy. Hence, the food materials which have the most fat and the least water have the highest fuel value. Butter and fat pork consist almost exclusively of fat. They lead the other food materials in fuel value. Lard, suet, and olive oil have even less water, and hence exceed the butter in this respect. Oleomargarine (see Table A) has just about the same composition, potential energy, and food value as butter. The different kinds of meat differ even more in proportions of fat than one would suppose from their appearance. The figures given in these tables represent the averages of analyses of American meats thus far made. Comparatively few samples have been analyzed, however, and probably future investigations will change these figures more or less. Indeed, meats are so variable in composition that it is very difficult to say just what are the average figures. Generally speaking, the veal makes the leanest and pork the fattest of ordinary meats. Mutton is apt to be a little fatter than beef. Of the different cuts of beef the loin, rump, and shoulder are among the leanest, while the ribs and flank the fattest. Mutton and lamb furnish about the same amount of protein and potential energy as the fatter cuts of beef. The loin is the fatter part of beef and mutton. This is especially the case with mutton, because the leaf fat is usually included with the loin as it is sold in the markets, while in the case of beef the tallow and suet, and in the case of swine the leaf lard, are cut out and used for the fat they contain.

Pork is so much fatter than the flesh of beef and mutton that even the strictly "lean cuts," as the lean after the removal of the leaf is called, contain relatively as much fat as the fattest cuts of other meats. The case is similar with smoked ham, though the large proportion of fat is due in part to the loss of water in preparation. Among the prepared meats, canned corned beef, which is ordinarily cooked before canning, is worthy of especial notice. It has a large amount of both protein and fats. Like most other kinds of canned meats, the corned beef is free from bone. It furnishes more protein, pound for pound, than most kinds of fresh beef, and stands very high in fuel value.

Chicken and turkey have less fat than the fatter meats. In spite of their large amount of refuse, bone, etc., they furnish quite large quantities of protein.

Fish have, in general, so much refuse and the flesh contains so much water that the proportions of nutrients are smaller than in ordinary meats. The white-fleshed fish, as cod and haddock, have very little fat. Fish with darker meats, such as shad and mackerel, are rich in fats. Salmon has considerable fat and approaches beef in composition. The difference in composition between dry, solid cod and fresh cod is due chiefly to the loss of water in the drying and salting. Many persons are surprised to learn that oysters have about the same proportions of nutrients as milk. Indeed, there is very little difference in the nutritive values of the two when estimated by the quantities of nutrients and energy. Milk is, however, more nearly a "perfect" or "normal" food, if it is right to call any single food perfect or normal. Oysters are so richly prized because of their flavor. Cheese made of whole milk contains nearly all of the nutrients of the milk except the milk sugar and hence comes very nearly being a concentrated form of milk. Cheese made of skim milk has less fat and hence relatively more protein.

Among the vegetable foods the chief differences to notice are the proportions of water and of protein. The quantities of water range from 90 per cent or more in beets and turnips to as low as 10 per cent in some kinds of flour. In general, dry seeds, like wheat, corn, and beans, and the different kinds of flour and meal prepared from them, contain not far from one-eighth water and seven-eighths nutrients. Beans and peas contain the largest proportions of protein, and corn meal, potatoes, rice, turnips, and beets the least. Among the cereals wheat is, on the whole, the highest in protein. Doubtless this is one chief reason why it is so largely used for food. Oatmeal has rather more protein than wheat. The comparison of wheat bread with wheat flour is interesting.

The chief difference in the composition of flour and bread is the proportions of water, which makes about one-eighth the weight of flour and one-third that of the bread. The average composition of wheat flour and the bakers' bread made from it is about as follows:

[Per cent.]

	Water.	Nutrients.					Potential energy in 1 pound.
		Total.	Protein.	Fats.	Carbohydrates.	Mineral matters.	
Wheat flour	12	88	12	9	75	1	2,000
Bakers' bread	32	68	9	2	56	1	1,300

In making the bread a little butter or lard, salt and yeast, and considerable water, either by itself or in milk, are added to the flour. The yeast

causes carbohydrates (sugar, etc) to ferment, yielding alcohol and carbonic acid in the form of gas, which makes the dough porous. In the baking the alcohol is changed to vapor and the carbonic acid is expanded, making bread still more porous, and both are mostly driven off. Part of the water escapes with them. The amount of sugar and other carbohydrates lost by the fermentation is not very large, generally from 1½ to 2 per cent of the weight of the flour used. With increase in the proportion of water in the bread as compared with the flour, the proportion of nutrients is diminished, but the addition of shortening and salt brings up the fat and minerals in the bread so that the proportions are larger than in the flour. In practice 100 pounds of flour will make from 133 to 137 pounds of bread, an average being about 136 pounds. Flour such as is used by bakers is now purchased in the Eastern States at not over $4 per barrel. This would make the cost of the flour in a pound of bread about 1½ cents. Allowing one-half cent for the shortening and salt, which is certainly very liberal, the materials for a pound of bread would cost not more than 2 cents. Of course there should be added to this the cost of labor, rent, interest on investment, expense of selling, etc., to make the actual cost to the baker.

Very few accurate weighings and analyses of bakers' bread have been made in this country, so far as I am aware, but the above statements represent the facts as nearly as I have been able to obtain them. The average weight of a number of specimens of 10-cent loaves purchased in Middletown, Conn., was 1¼ pounds. This makes the price to the consumer 8 cents per pound. The price of bread and the size of the loaf are practically the same now as when flour cost twice as much.

The cost of bakers' bread is a comparatively small matter to the person who only buys a loaf now and then, but in the Eastern States and in the larger towns throughout the country many people, and especially those with moderate incomes and the poor, buy their bread of the baker. Six cents a pound, or even half that amount, for the manufacture and distribution seems a very large amount.

In the large cities competition has made bread much cheaper, but even there the difference between the cost of bread to the well-to-do family who bake it themselves and to the family of the poor man who buys it of the baker is unfortunately large.

PECUNIARY ECONOMY OF FOOD.

Amounts of nutrients obtained for 25 cents in materials as purchased at ordinary prices.

Food materials as purchased.	Price per pound.	25 cents will pay for—					
		Total food materials.	Nutrients.				Potential energy.
			Total.	Protein.	Fats.	Carbohydrates.	
MEATS, ETC.							
Beef.	*Cents.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Neck	8	3.13	0.95	0.49	0.44	.....	2,765
Do	6	4.17	1.27	.65	.58	.....	3,655
Chuck ribs	16	1.56	.56	.23	.31	.....	1,735
Do	12	2.08	.75	.31	.42	.....	2,350
Ribs	22	1.14	.47	.14	.32	.....	1,610
Do	16	1.39	.57	.17	.39	.....	1,960
Shoulder	14	1.79	.57	.30	.25	.....	1,615
Do	10	2.50	.79	.43	.34	.....	2,235
Sirloin	22	1.14	.37	.17	.19	.....	1,125
Do	18	1.39	.45	.21	.23	.....	1,360
Rump	18	1.39	.63	.19	.43	.....	2,170
Do	15	1.67	.76	.23	.52	.....	2,620
Round, first cut	18	1.39	.44	.25	.17	.....	1,180
Do	15	1.67	.52	.30	.21	.....	1,445
Round, second cut	10	2.50	.52	.35	.15	.....	1,285
Do	8	3.13	.65	.44	.18	.....	1,580
Neck	6	4.17	1.07	.54	.53	.....	3,240
Do	5	5.	1.29	.65	.64	.....	3,910
Chuck, C. E	6	4.17	1.10	.67	.43	.....	3,060
Do	9	2.77	.74	.45	.29	.....	2,060
Fore shank, C. E	4	6.25	1.20	.80	.40	.....	3,175
Rib, C. E	10	2.50	.75	.35	.40	.....	2,340
Do	7	3.57	.26	.50	.76	.....	4,135
Plate, C. E	5	5	1.77	.71	1.06	.....	5,795
Do	18	1.39	1.39	.20	.19	.....	1,175
Loin, C. E	14	1.79	.51	.26	.25	.....	1,540
Do	14	1.79	.53	.25	.28	.....	1,645
Flank, C. E	6	4.17	1.52	.75	.77	.....	4,645
Rump, C. E	10	2.50	.79	.30	.49	.....	2,625
Do	14	1.79	.48	.32	.16	.....	1,270
Round, C. E	12	2.08	.56	.37	.19	.....	1,490
Do	10	2.50	.70	.45	.25	.....	1,890
Do	14	1.79	.57	.22	.35	.....	1,885
Hind shank, C. E	5	5	.71	.47	.24	.....	1,885
Flank, corned	15	1.67	.74	.21	.49	.....	2,460
Do	10	2.50	1.11	.31	.73	.....	3,655
Corned and canned	18	1.39	.66	.37	.24	.....	1,700
Do	14	1.79	.85	.48	.31	.....	2,200
Do	16	1.56	.70	.41	.29	.....	1,995
Canned corn beef, C. E	14	1.79	.81	.48	.33	.....	2,285
Do	12	2.08	.94	.55	.39	.....	2,670
Liver	8	3.13	.96	.63	.17	0.11	2,095
Mutton.							
Shoulder	15	1.67	.58	.25	.31	.....	1,775
Do	25	1	.31	.15	.16	.....	955
Leg	20	1.25	.39	.19	.20	.....	1,195
Do	20	1.25	.44	.19	.24	.....	1,365
Loin	25	1	.43	.13	.29	.....	1,465
Do	20	1.25	.53	.16	.37	.....	1,860
Pork.							
Rib roast	12	2.08	.88	.28	.58	.....	2,970
Do	10	2.50	1.06	.34	.70	.....	3,585
Smoked ham, whole	16	1.56	.81	.23	.54	.....	2,705
Do	12	2.08	1.08	.31	.72	.....	3,615
Ham, C. E	16	1.56	.75	.21	.54	.....	2,670
Do	12	2.08	.82	.28	.72	.....	3,560
Shoulder, C. E	14	1.79	.82	.23	.59	.....	2,920
Do	10	2.50	1.14	.32	.82	.....	4,055
Salt fat pork	15	1.67	1.46	.02	1.38	.....	5,860
Do	12	2.08	1.83	.02	1.72	.....	7,295
Pork, sausage	15	1.67	.98	.23	.72	.....	3,465
Do	12	2.08	1.22	.29	.89	.....	4,295
Poultry.							
Chicken	22	1.14	.20	.17	.02	.....	400
Do	16	1.56	.27	.24	.02	.....	530
Turkey	23	1.09	.25	.18	.06	.....	590
Do	18	1.39	.31	.22	.08	.....	745

PECUNIARY ECONOMY OF FOOD—Continued.

Amounts of nutrients obtained for 25 cents in materials as purchased at ordinary prices—Continued.

Food materials as purchased.	Price per pound.	25 cents will pay for—					
		Total food materials.	Nutrients.				Potential energy.
			Total.	Protein.	Fats.	Carbohydrates.	
MEATS, ETC.—continued.							
Fish.	*Cents.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Shad, whole	15	1.67	0.25	0.15	0.09	.....	660
Do	10	2.50	.37	.23	.12	.....	935
Mackerel, whole	15	1.67	.25	.17	.07	.....	610
Do	10	2.50	.37	.25	.11	.....	930
Do	18	1.39	.22	.14	.06	.....	515
Blue fish, dressed	15	1.67	.19	.16	.01	.....	340
Do	10	2.50	.28	.25	.02	.....	550
Striped bass, whole	18	1.39	.14	.12	.01	.....	265
Do	12	2.08	.21	.17	.02	.....	400
Haddock, dressed	8	3.13	.28	.26	.01	.....	525
Do	5	5	.45	.41	.01	.....	805
Cod, dressed	10	2.50	.29	.27	.01	.....	545
Do	8	3.13	.36	.33	.01	.....	655
Do	6	4.17	.48	.44	.01	.....	860
Halibut, steaks	20	1.25	.26	.19	.06	.....	605
Do	16	1.56	.32	.24	.07	.....	740
Salt cod	8	3.13	.55	.50	.01	.....	970
Do	5	5	.88	.80	.02	.....	1,570
Salt mackerel	16	1.56	.49	.23	.24	.....	1,440
Do	12	2.08	.66	.31	.32	.....	1,925
Canned salmon	20	1.25	.46	.25	.20	.....	1,310
Oysters (50 cents per quart)	25	1	.13	.06	.01	0.04	230
Oysters (35 cents per quart)	17.5	1.43	.18	.09	.02	.05	345
Lobsters, whole	12	2.08	.14	.11	.01	.....	245
Do	10	2.50	.17	.14	.02	.....	345
Lobsters, canned	20	1.25	.28	.23	.01	.....	470
EGGS AND DAIRY PRODUCTS.							
Eggs (35 cents per dozen)	25	1	.23	.12	.10	.....	645
Eggs (25 cents per dozen)	18.2	1.37	.32	.17	.14	.....	910
Eggs (15 cents per dozen)	11	2.27	.53	.28	.23	.....	1,490
Milk (8 cents per quart)	4	6.25	.81	.23	.25	.29	2,020
Milk (6 cents per quart)	3	8.33	1.08	.30	.33	.39	2,675
Milk (4 cents per quart)	2	12.50	1.63	.45	.50	.59	4,045
Butter	35	.71	.64	.01	.60	.....	2,550
Do	30	.83	.74	.01	.71	.....	3,015
Do	25	1	.90	.01	.85	.01	3,625
Do	18	1.39	.96	.40	.49	.02	2,850
Cheese, whole milk	15	1.67	1.17	.47	.59	.03	3,420
Do	12	2.08	1.45	.59	.72	.04	4,210
Potatoes ($1 per bushel)	1.67	15	2.69	.27	.01	2.28	4,785
Potatoes (80 cents per bushel)	1.33	19	3.41	.34	.02	2.09	6,090
Potatoes (50 cents per bushel)	.83	30	5.38	.54	.02	4.56	9,570
Sweet potatoes	5	5	1.27	.07	.02	1.14	2,335
Do	3	8.33	2.11	.10	.03	1.89	3,830
Beets	2	12.50	1.23	.16	.01	.94	2,090
Do	1	25	2.45	.32	.02	1.87	4,180
Turnips	2	12.50	.93	.11	.02	.72	1,630
Do	1	25	1.86	.22	.04	1.44	3,260
Sugar	5	5	4.90	.....	.....	4.89	9,095
Do	6	4.17	3.64	.96	.09	2.47	6,760
Dried beans	5	5	4.37	1.15	.10	2.96	8,065
Do	4	6.25	5.46	1.44	.13	3.70	11,110
Maize corn meal	3	8.33	7.08	.77	.32	5.88	13,720
Do	1	25	21.25	2.30	.95	17.65	41,160
Oatmeal	5	5	4.62	.76	.36	3.41	9,275
Do	4	6.25	5.47	.69	.07	4.68	10,285
Wheat flour	3.5	7.14	6.25	.79	.08	5.35	11,755
Do	3	8.33	7.29	.92	.09	6.24	13,695
Wheat bread	7	3.57	2.42	.31	.06	2.01	4,570
Do	5	5	3.38	.44	.09	2.82	6,445
Crackers, Boston	12	2.08	1.91	.22	.21	1.43	3,955
Do	8	3.13	2.87	.33	.31	2.15	5,920

DIETARY OF JAVANESE AT THE WORLD'S FAIR.

In connection with the study of the food of some of the interesting people from the less-known countries at the World's Fair, specimens were collected at several exhibits in the agricultural, fisheries, and liberal arts buildings and in the Midway Plaisance. The most of the people in the Midway exhibits lived upon food purchased in Chicago. Several companies, however, had brought food with them from home. This was the case with some of the Turks and Bedouins, but none of these lived so exclusively upon their home diet and in such regular ways as to make a satisfactory study of their food consumption practicable.

In the Java Village the home food was used and the home customs were very closely followed, and the people lived very much as they do at home. A large kitchen, which was not open to the public, was arranged in the Javanese manner. It was provided with native utensils and the work was done by native cooks and servants. At the time the observations were made, however, the supply of rice brought with them was nearly exhausted and rice purchased in Chicago was being used. Analyses showed very little difference in the composition of the two kinds. A small quantity of bread, made in Chicago, was used with the rice, thus changing their dietary from the common one in which very little cereal food other than rice is used.

The people were very intelligent and courteous. Indeed, their intellectual and social status was not appreciated by visitors, many of whom regarded them as little else than curiosities. It was my privilege to become acquainted with some of them, and I could see that they had excellent reason to feel annoyed by the estimate in which they were held—an estimate due in part to our lack of knowledge of the Javanese nature and their customs, and in part to the fact of their being in the Midway. Through the courtesy of the gentlemen in charge of the village, especially Mr. Ferrari, its superintendent, who appreciated the scientific value of such inquiries and entered into the matter with the interest of an anthropologist, ample facilities were offered for a dietary study.

One of the houses was set apart for the purpose, and two families, including two women and three men, were assigned to live in it for a period of nearly two weeks, and enjoined to eat nothing except what was served in the house. The cooks were charged to provide the fullest opportunity for collecting the data desired. The details of weighing the food materials, taking specimens for analysis, and watching the preparation and serving of the food were intrusted to Miss Amelia Shapleigh, of Cambridge, Mass., who collected specimens of food materials and made observations regarding their use in the Samoan, Turkish, Bedouin, and other villages of the Midway Plai-

sance. Miss Shapleigh had been the recipient of the Dutton fellowship of the College Settlements Association for 1892–93, and in its use had collected the dietaries of families in Philadelphia and Chicago. She was thus well fitted for the work in which a man could hardly have succeeded so well. Dr. H. B. Gibson, who has been associated with myself in the study of dietaries for some years, and who shared in the investigation of foods at the World's Fair, assisted in the observation of the Javanese dietary, visiting the place and people with Miss Shapleigh and myself for the purpose. He has had charge of the analyses of the food materials and calculation of the results. The observations were made during the ten days from September 18 to 27, inclusive. The weights of the three men were 130, 130, and 131½ pounds, and those of the two women 83 and 119 pounds, respectively. The men were engaged, to a more or less extent, in the light occupations incident to the care of the village, and in sewing. They were much interested in American sewing machines, as will be remembered by visitors who noticed the machines in the houses of the village. The women seemed to have no special occupation outside the very small amount involved in the care of the house.

The food consisted mainly of rice and lean beef, the former furnishing nearly seven-tenths, and the two together nearly five-sixths, of the total actual nutrients. In addition, chicken, fish, eggs, bread, green vegetables and fruits were eaten in small quantities. So far as we could learn this did not differ very greatly from their home diet. The details of weighing for each day are as follows:

Weights of daily food materials in Javanese dietary.

Monday, September 18, 1893.—Steamed rice, 3 pounds 8½ ounces; dried meat, 5½ ounces; bread, 11 ounces; cabbage, 3¾ ounces; red peppers, 1 ounce; cabbage, 4¾ ounces; scrambled eggs, 7 ounces.

Tuesday, September 19, 1893.—Steamed rice, 4 pounds 3¾ ounces; beefsteak, 13 ounces (cooked); bread, 15 ounces; egg plant, 1 pound 5½ ounces (cooked); eggs, 4 ounces (cooked); cucumbers, 14 ounces; peppers, 3½ ounces; white grapes, 6 ounces; pears, 9½ ounces; cabbage, 7¼ ounces.

Wednesday, September 20, 1893 (not complete).—Steamed rice, 2 pounds 5 ounces; dried meat, 4¾ ounces; vegetable soup, 15 ounces; blueberry and apple pie, 1 pound; cabbage, 9 ounces.

Thursday, September 21, 1893.—Steamed rice, 5 pounds 8 ounces; bread, 14½ ounces; steak, 14¾ ounces (cooked); chicken, 1 pound 1½ ounces (cooked); cabbage, 1 pound; scrambled eggs, 7¾ ounces; beets, 6½ ounces (cooked); squash, 3½ ounces (cooked). Each person ate 1 pear, 1 orange, and 1 banana. The approximate weight of the 5 pears was 1 pound 14 ounces; the 5 oranges, 2 pounds; and the 5 bananas, 1 pound 1⅞ ounces.

Friday, September 22, 1893.—Steamed rice, 4 pounds 8¼ ounces; dried meat, 5½ ounces; chicken, 4 ounces (cooked); cabbage, 10½ ounces; cucumbers, 15½ ounces; lettuce, ¾ ounce.

Saturday, September 23, 1893.—Steamed rice, 5 pounds 9½ ounces; steak, 1 pound 3 ounces (cooked); eggs, 6¼ ounces (cooked); lettuce, 1½ ounces; cucumbers, 4 ounces.

Sunday, September 24, 1893.—Steamed rice, 5 pounds 13¾ ounces; steak, 1 pound 15¼ ounces (cooked); cabbage, 5½ ounces; onions, 7¾ ounces.

Monday, September 25, 1893.—Steamed rice, 5 pounds 6¾ ounces; steak, 14¼ ounces (cooked); bread, 1 pound 2 ounces.

Tuesday, September 26, 1893.—Steamed rice, 5 pounds 6¾ ounces; chicken, 6 ounces (cooked); steak, 12¾ ounces (cooked); cabbage, 5 ounces.

Wednesday, September 27, 1893.—Steamed rice, 5 pounds 9¾ ounces; steak, 1 pound ¾ ounce (cooked); bread, 1 pound 10½ ounces; fish and mackerel during the ten days, 12 ounces.

On Thursday, September 21, a wedding occurred in the village, which was celebrated by a kind of feast. The variety of food on that day was greater than on the others.

The data for the first three days, Monday, Tuesday, and Wednesday, were not entirely satisfactory, as the people did not then appreciate the importance of being exact, and on one or two occasions ate some material which had not been weighed. They knew no English, it was difficult to make them understand, and the interpreter was so busy as not to be able to be on hand at all times when we wished to communicate. The figures for Wednesday, the 20th, were not entirely complete, and are not included in the estimates beyond; those for Monday and Tuesday are, however, included. Although we had reason to suspect that very small amounts of some other materials had been consumed on Monday and Tuesday, it seemed reasonably safe to assume that the quantities had not been large enough to materially affect the results. There was every reason to believe that the quantities for the other days, as found by the weighings, represented those actually furnished. The people were entirely well disposed, and when they once found what was really wanted of them seemed quite ready to conform to regulations. It seems entirely improbable that they could have procured food surreptitiously, even if they had been inclined to do so. They had been expressly warned against this by the manager, and they were permitted to eat as much as they wished of the food with which they were supplied in common with the other inmates of the village.

Table 1 gives the actual amounts of food and of nutrients in the food used during the nine days of the dietary which are specified above. The first three columns give the percentages of nutrients in the food materials, and were obtained as follows: The figures for round steak are the average of all the analyses of specimens of round steak obtained for analyses at the World's Fair; those for the dried beef from Java are from an actual analysis. The composition of the fish is the average of analyses of two specimens of Asiatic fish (one from Java and the other from Syria) obtained at the World's Fair.

Boiled rice was by far the most important food material of the dietary, and in order to ascertain its composition with the greatest possible accuracy several samples were taken in sealed bottles from the

kitchen of the village to the laboratory and there weighed, mixed, dried, and analyzed. The composition of the other food materials, with the exception of that of the red peppers, which is assumed from German analyses, is based upon the average of analyses of American food products.[a]

TABLE 1.—*Food materials in Javanese dietary.*

[100 grams=3.5 ounces or 0.22 pound; 1 ounce=28.35 grams; 1 pound=453.6 grams.]

Food materials.	Composition.			Weights.			
					Nutrients.		
	Protein.	Fats.	Carbohydrates.	Total food materials.	Protein.	Fats.	Carbohydrates.
ANIMAL FOODS.							
Beef:	*Per cent.*	*Per cent.*	*Per cent.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Round[a]	19.6	12.9	.....	[b] 4,253	834	548	.....
Dried (Java)	66.8	4.7	.....	304	203	14	.....
Total	.....	.....	.....	4,557	1,037	562	.....
Chicken[a]	24.4	2	.....	[b] 936	228	19	.....
Total meats	.....	.....	.....	5,493	1,265	581	.....
Fish	17.3	8.4	.....	306	53	26	.....
Eggs (shell contents)[a]	14.9	10.5	.....	[b] 731	109	77	.....
Total animal food	.....	.....	.....	6,530	1,427	684	.....
VEGETABLE FOODS.							
Boiled rice	6	.1	41.9	20,723	1,037	21	8,692
Cabbage	1.5	.2	4.6	1,495	22	3	69
Lettuce	1.6	.5	3.7	71	1	.....	3
Red peppers	4.2	1.7	11.6	128	5	2	15
Eggplant[a]	1.2	.3	5.1	[b] 732	9	2	37
Cucumber	.8	.2	2.5	943	8	2	24
Beet[a]	1.5	.1	8.8	[b] 221	3	.....	19
Squash[a]	.9	.2	10.1	[b] 119	1	.....	12
Onions	1.4	.3	10.1	220	3	1	22
White grapes[c]	1.6	1.7	21.3	127	2	2	27
Pears[c]	.6	.8	14.2	840	5	7	119
Oranges[c]	1	.9	8.3	562	6	5	47
Bananas[c]	1.4	1.4	28.9	307	4	4	89
Bread	8.8	1.7	56.3	2,410	212	40	1,354
Total vegetable food	.....	.....	.....	28,898	1,318	89	10,529
Total animal and vegetable food	.....	.....	.....	35,428	2,745	773	10,529

[a] Cooked. [b] Estimated weight, uncooked. [c] Edible portion.

Table 2 contains a summary of Table 1 and also the weights of food and of nutrients consumed per man per day; the weights are given in pounds as well as in grams. At the close of the table the relative proportions of the different classes of food materials and those of the nutrients furnished by each class are expressed in percentages.

[a] See Report of Storrs Agricultural Experiment Station, 1891, p. 80.

TABLE 2.—*Weights and percentages of food materials and of nutritive ingredients used in Javanese dietary.*

[100 grams = 3.5 ounces or 0.22 pound; 1 ounce = 28.35 grams; 1 pound = 453.6 grams.]

Kinds of food materials.	Weight				Weight.			
	Food materials.	Nutrients.			Food materials.	Nutrients.		
		Protein.	Fats.	Carbohydrates.		Protein.	Fats.	Carbohydrates.
For 5 persons, 9 days:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Meats, etc.	5,493	1,265	581	.....	12.1	2.8	1.3	.....
Fish	306	53	26	.....	.7	.1	.1	.....
Eggs	731	109	77	.....	1.6	.2	.2	.....
Total animal food	6,530	1,427	684	.....	14.4	3.1	1.6	.....
Vegetable food	23,898	1,318	89	10,529	63.7	2.9	.2	23.2
Total animal and vegetable food	35,428	2,745	773	10,529	78.1	6	1.8	23.2
Per man per day:								
Meats, etc.	133	30.3	14.4	.....	.293	.066	.032	.....
Fish	7	1.3	.6	.....	.015	.003	.001	.....
Eggs	18	2.6	1.9	.....	.040	.006	.004	.....
Total animal food	158	34.2	16.9	.....	.348	.075	.037	.....
Vegetable food	698	31.8	2.1	254.3	1.539	.071	.005	.560
Total food	856	66	19	254.3	1.887	.146	.042	.560
Percentage of total food:								
Meats, etc.	15.4	45.8	75.6	.....	.....	.....	.....	.....
Fish	.9	2	3.3	.....	.....	.....	.....	.....
Eggs	2.1	4	9.8	.....	.....	.....	.....	.....
Total animal food	18.4	51.8	88.7	.....	.....	.....	.....	.....
Vegetable food	81.6	48.2	11.3	100	.....	.....	.....	.....
Total food	100	100	100	100	.....	.....	.....	.....

Table 3 gives the total amounts of potential energy furnished by the animal and the vegetable food of the dietary; also the amounts per man per day and the relative proportion of the energy furnished by both classes of foods expressed in percentages.

TABLE 3.—*Nutrients and potential energy in food of Javanese dietary.*

[100 grams = 3.5 ounces or 0.22 pound; 1 ounce = 28.35 grams; 1 pound = 453.6 grams.]

Food.	Nutrients.			Potential energy.
	Protein.	Fats.	Carbohydrates.	
For 5 persons, 9 days:	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Animal	1,427	684	.....	12,210
Vegetable	1,318	89	10,529	49,400
Total	2,745	773	10,529	61,610
Per man per day:				
Animal	34	17	.....	300
Vegetable	32	2	254	1,190
Total	66	19	254	1,490
Percentage of total food:				
Animal	51.8	88.7	.....	20.1
Vegetable	48.2	11.3	100	79.9
Total	100	100	100	100

Economics in Foods— Wastefulness of Americans— Workingmen in this country are better fed than are those abroad.

Statistics, as well as common observations, bear emphatic testimony to the better condition of the American as compared with the European workingman, in respect to his supply of the necessaries and comforts of life. Nowhere is this superiority more striking than in the quality and quantity of the food. The difference in the dietaries of the two is especially marked in the larger amounts of protein, which forms the muscle and other parts of the framework of the body, and of potential energy of capability to yield muscular strength for work, which characterizes the food of the Americans.

The exact statistics of food consumption of laboring people in the United States and in Europe are very limited. Extended studies will be needed to justify numerical statements of comparative amounts of food consumed. If the data now available are to be taken as representative, the inference will be that the daily food of mechanics and kindred wage-workers in the Eastern, if not in the whole United States, is not only the larger in quantity, but also is the more nutritive in quality, because of the larger amount of meat, fish, milk, and other animal foods. In material for building muscle and other tissues, and for supplying heat and muscular strength, it exceeds that of people of corresponding occupation on the Continent of Europe by at least one-third and perhaps one-half.

The smallest among American dietaries of this class examined furnished 3,200 calories of energy a day to each man. The average of seven dietaries of 421 persons in Massachusetts, of factory operatives, mechanics, etc., at moderate work, was 4,415 calories, and that of four dietaries of mechanics and laborers in Connecticut at severe work, 6,705. In this latter the dietary of the Massachusetts brickmakers, with their 8,850 calories, was not included. The average of dietaries of wage workers in the two States named was 6,656 calories. In a large number of European dietaries of which I have obtained statistics there are many which range from only 1,700 to 1,900 calories. Of course these are of relatively poor people. The average of eleven dietaries of poorly fed wage workers in Saxony and Prussia is 2,290. The average of the same number of dietaries of well-paid mechanics in Bavaria is 3,150. The largest European dietary I have found on record for men in ordinary conditions, even with the severest labor, gives in the neighborhood of 4,500. The American workingmen whose dietaries were examined were better nourished by half than their trans-Atlantic brethren. These comparisons have, I believe, a profound significance.

BETTER CONDITION OF THE AMERICAN.

The American workingman is better paid, better housed, better clothed, and better fed than the European. He has better opportunity for self-development, more to stimulate his ambition, and more hope of reward if his work is efficient. He accomplishes a great deal more. That this superiority is due to more nutritious food, as well as to greater intelligence, is hardly to be questioned.

The dietary statistics above cited, taken with the collateral facts, lead to the inference that ordinary people have with us what only the exceptionally well-fed people have on the other side of the Atlantic—the food they need to make the most of themselves and their work. Indeed, is it not safe to say that, so far as the facts at hand go, they imply very distinctly that to the American workingman is vouchsafed the priceless gift which is denied to most people of the world—namely, the physical conditions, including especially the liberal nourishment, which are essential to large production, high wages, and the highest physical existence—and that as a corallary he has a like peculiar opportunity for intellectual and moral development and progress? To my own mind the saddest part of the picture that one sees among the industrious and worthy members of the poorly paid and poorly fed classes in Europe is not the physical want but the spiritual poverty, the lack of buoyancy, the mute, hopeless endurance of their lives. And by contrast the happiest feature in the condition of wage workers with us is not simply that they have better food, better clothing, better houses, and a better material existence in general, but that they have what these things bring—the vigor, the ambition, the hope for higher things—and that their effort leads them to the realization of their hope.

The general principle here urged is that liberal food, large production, and higher wages go together. If this be true the connection between the American's generous diet and his high wages is very clear.

ECONOMY IN FOOD PRODUCTION.

But the better nourishment of the American wage-worker is largely due to our abundant food production. With the growth of population and the increasing closeness of home and international competition his own diet can not be kept up to its present nutritive standard, nor that of his poorer neighbor and his foreign brother be brought up to that standard, without better knowledge and application of the laws of food economy.

The question naturally follows: What is to be done for the future maintenance of the position of our laboring people at home, and in their competition with others in the markets of the world? Part of the answer, at any rate, must be sought in a reform in the purchase and use of food. Instead of our present wastefulness there must be

future saving. With increase of population and closer competition with the rest of the world, the abundance which tempts us to our lavishness must grow gradually less, and closer economy will be needed for living on our present plane of nutrition.

To the farmer this subject is of vital interest. The agricultural production of the United States is out of balance. Our food supply for man and beast contains an excess of the materials which serve the body for fuel, and are relatively deficient in the nitrogenous compounds which make blood, muscle, and bone.

In other words, the farmer produces relatively too much starch, sugar, and other carbobydrates; too much fat and too little protein. The crops he grows are, taken together, deficient in protein, and the meat he makes is excessively fat. The one-sidedness of our food consumption is the natural result of the one-sidedness of our food production.

This one-sidedness of our agricultural production is easily explained. In the first place, our vegetable products are deficient in protein, Corn, our great staple, is poor in protein at best. From careless culture, insufficient manuring, or other reasons, our grasses, grains, and other crops contain much lower proportions of nitrogen than they ought to contain. Grasses that are well cultivated and well manured not only yield large crops, but the product is more valuable, pound for pound, because it is richer in protein. The same is true of other forage crops and with corn, and appears to be true to greater or less extent of other grains.

MEATS GROWING POORER IN PROTEIN.

In the better-cultivated parts of Europe much larger crops are generally grown than is usual with us. The statistics at hand imply that the grasses and forage crops at least are much richer in nitrogen.

It looks very much as though we have by careless culture and insufficient manuring of our grasses and other forage crops, if not our grains, for years been gradually breeding varieties poorer in protein, while our trans-Atlantic brethren have been pursuing the opposite course. Certain it is that our grasses often contain smaller percentages of protein than are found in the best qualities of cornstalks and even straw.

In the second place, our meats, upon which we depend to supply the protein our vegetable foods lack, are excessively fat. This is brought out very emphatically in the analyses of meats at the World's Fair.

In a compilation by Konig of analyses of food materials the average of the European analyses (French, German, and Austrian) of beef gives 5.4 per cent of fat as the average for "medium fat" and 29.3 per cent for "very fat" beef. The American analyses averaged in the same way would show nearly 30 per cent in medium and perhaps 40 per cent in very fat beef.

The so-called "fattening" of animals is properly an increase of flesh, both lean and fat, though more lean than fat is formed. The lean of the meat is formed from the protein of the food and from the protein alone. The fat of the flesh is formed from the fat of the food, but it is formed from carbohydrates also and may be formed, in part, even from the protein of the food. The flesh will leave relatively more of lean or fat as the food has more or less protein. That is to say, to get the animal into good condition for slaughtering it must be fed up to a certain condition of flesh, and the proportion of lean and fat in the flesh will depend more or less upon the food. We are accustomed in this country to associate tenderness, juiciness, and fine flavor with excessive fatness, because our nicest meats are generally very fat. But with more protein and less carbohydrates in the food we might have the tender, juicy, and fine-flavored meat without so much fat; at least, such is the inference from the facts at hand.

MAKING FAT OF THE HARVESTS.

While the excessive fatness of our meats is due in part to lack of protein and excess of carbohydrates in the feeding stuffs, it is also due in part to the fact that we have a great excess of soil product in the valleys of the Ohio and Mississippi rivers and on the ranches of the West, and the natural tendency is to condense as much as possible of it into meat.

The manufacture of meat is a process of transforming the vegetable protein, carbohydrates, and fats of grass and grain into the animal protein and fat of beef, mutton, and pork. In the normal growth of the young animal to maturity a considerable portion of muscle, tendon, and other tissue, of which protein is the basis, is formed from the protein of the food, but in the latter stages of fattening it is chiefly fat which is made from the food and stored in the body. As the animal becomes fatter relatively less protein is formed and the material stored becomes more and more exclusively fat. At present the swine grower in the corn-producing States and the grower of cattle in those States and in the Western ranges convert a large part of the soil product of the country into the fat of beef and pork. The European feeder can not afford this extravagance. His soil product is too precious. His feeding stuffs are richer in protein than our grasses and grain. He makes tender, juicy beef, of excellent flavor without excess of fats. People there do not call for the lean of overfattened meat and reject the fat, as they do here. When the cattle he is fattening have been fed to the point where the quantity of fat in the meat is reasonable and the flavor acceptable they are slaughtered. For him to keep on feeding them and transform a large amount of the protein, fats, and carbodydrates of his feeding stuffs into a relatively small amount of extra fat in the meat would be ruinous to the profit of his feeding.

The excessive production of fat in our meats is uneconomical in several ways. The production uses a large amount of vegetable material to make a small amount of fat, protein is lost in the process, and the fat thus produced is sold in a market relatively overstocked with fat. The consumer buys fat that he does not need in order to get the lean he wants, he eats part of the extra fat and throws away the rest, and is injured in both purse and health thereby.

REPLACING WATER WITH FAT.

This subject is so important that I venture to add a few more words regarding it. Late research in the chemistry and physiology of meat production has disclosed some facts which have not yet become generally known and which emphasize the poor economy of excessive fattening.

We see lumps of what we call fat in meat, but the microscope and chemical analysis reveal a surprisingly large amount in the clear, red, muscular tissue which we call lean. It appears that these microscopic particles of fat take the place of water in the minute cells in the tissue, somewhat as shot dropped in a vessel filled with water drive out their volume of water from the vessel. This helps to explain why the quantity of fat in the meat may be so much larger than appears to the eye.

The feeder who makes use of the nutrition machinery of his cattle to manufacture the lean and fat of meat from grass and grain, instead of stopping when the formation of protein is practically complete and a reasonable amount of fat has been produced, keeps on feeding, and is satisfied because his animals continue to increase in weight and he can get a good price for highly-fattened beef. With the taste for beef and the price which such meat brings as they are, he may for the time be justified in doing so. He does not know, however, that in the last stages of the fattening he is driving water out of the animal's tissue and putting fat in its place, and that as this fat does not increase the animal's weight he gets no pay for it when he sells it.

The consumer of the meat, if he be a man with hard muscular work and without enough fuel material in his food otherwise, reaps a benefit from this extra fat, but must pay dearly for it at the prices at which the fatter kinds of beef are sold, for the simple reason that so much material was used to make it. He might much better get the same fuel material in other foods at a fraction of the cost. If he is like many of his fellow-workingmen he will not need it, for his other food will supply an abundance and the very fat meat will be simply an expensive luxury. If, on the other hand, he be a man of less active physical exercise, with such a diet as the facts stated in the preceding pages imply that very many if not most of the people of the country in his circumstances live upon, he will have an excess of

fat in his diet and will consume part of the excess and reject the rest. Both of the parties to the transaction, producer and consumer, are, therefore, losers from this abnormal production.

MISTAKES IN POPULAR TASTE.

There is, it is true, a large demand for fat beef. That is because fat beef as we produce it, is tender, juicy, and attractive in flavor, and it is not the fat but the lean that is most wanted. It may not be safe to affirm without positive demonstration that by proper feeding just as palatable meat could be produced in this country with less fat. But such meat is produced, as those who travel on the continent of Europe have abundant occasion to observe. How to fatten beef so as to have less fat and more lean without sacrificing texture or flavor is an important thing to learn.

How to do this with pork has been very clearly shown by feeding experiments at several experiment stations, notably in Wisconsin. The method is simple. It consists in feeding more protein. The pork producers of the great corn-growing States select the breeds of swine which, as they say, "will take the most corn to market," and have thus got into the way of growing animals that are, to use a common expression, "little else than masses of fat." The success which swine breeders have attained in producing animals especially fitted for fattening is opposed to true economy. What is needed is to save our protein and produce less fat and carbohydrates. But the hog as bred for fattening is an organism with a phenomenal capacity for consuming protein and carbohydrates and producing fats.

The pork producer in this country has come to be essentially a manufacturer of fat. Like other manufacturers, he must compete in the markets of the world, home and foreign. He meets serious competition in the fat of other meats, in cotton-seed oil, in sugar, and in petroleum. The home market is relatively overstocked with fat pork.

There are, then, two things for the pork producer to do: Make leaner pork and get better access to foreign markets. Leaner pork can be obtained by the use of nitrogenous foods, skim milk, bran, shorts, cotton-seed meal—if it can be advantageously utilized—beans, pease, clover, alfalfa, and other leguminous plants.

To facilitate access to foreign markets the facts regarding the need and value of our American products must be brought out clearly. Of course this will require much research. The process must be slow and no one can positively predict the results. But it is at any rate safe to say that the facts now at hand are such as to promise a very strong argument.

ANALYSES OF FRESH MEATS.

Such studies as I have been able to make of our food products during a number of years past have impressed upon me the great desirability of examinations of the fresh meats which are distributed in such large quantities from Chicago and other centers of meat industry. It is well known that in large areas of the country but little meat is slaughtered in either the cities or the country towns, nearly the whole supply coming from the West. The meat thus distributed and sold varies greatly in quality, chemical composition, and nutritive value. It is certainly desirable that people should know something about the amounts of actual nutriment in the meats they buy, and the ratio of nutritive value to actual cost. The great difficulty has been that a large number of specimens needed to be analyzed in order to give at all satisfactory results. Some years ago a beginning was made in connection with an investigation in the chemical laboratory of Wesleyan University under the auspices of the United States National Museum. From a carload of beef shipped from Chicago to Middletown, Conn., a side, which was judged by an expert to be of about average fatness, was selected for examination. The whole side was weighed and then cut into somewhat more than twenty pieces, in accordance with the method of cutting commonly followed in Fulton Market, New York.

These individual cuts were brought to the laboratory and weighed. The edible portion was separated from the bone and other refuse and the proportions of meat and refuse determined. The meat—i. e., edible portion—was then analyzed. Similar analyses were made of sides of mutton and lamb. These analyses and a number of similar ones made of individual cuts of beef, mutton, veal, pork, and other meats, in connection with studies of dietaries which have been carried on in the same laboratory, have furnished practically all of the data available up to the present time regarding the actual composition and nutritive values of American meats.

The exhibits of meats at the World's Fair included displays of fresh meats and of the methods used for their transportation, especially in refrigerator cars. The desirability of extended studies in this direction was speedily apparent to the members of the jury on food products and the matter was laid before the chairman of the executive committee on awards, who heartily encouraged the investigation. The importance of such study was also appreciated by the exhibitors. Mr. Mixer took pains to explain it to three of the principal packing firms in Chicago, Messrs. Armour & Co., Swift & Co., and Nelson, Morris & Co. The heads of these establishments entered into the matter with great interest. The superintendents and other gentlemen at the stock yards were charged to aid the investigation, which they

did most cordially, and every facility was provided for obtaining specimens and information.

On careful consideration it seemed desirable to take a large number of specimens of beef, mutton, veal, and pork, and to make the number and variety such as to represent reasonably well the range of variation in character and composition of the products slaughtered in Chicago and distributed from there. Thus, in selecting the beef it was decided to take several specimens of cattle as they come direct from Texas; of others from ranches in the West, as Colorado or Montana, and of still others from the great corn-producing regions like Illinois. Several typical specimens were taken from each of these regions; some of them were quite lean, others were of medium fatness, still others were very fat, but each was selected as typical of the class of animals of the region from which it came. The range of grades of veal, mutton, and pork is less wide, and the number of typical specimens selected was hence smaller. The number of specimens of fresh pork was small, because the shipment of fresh pork from Chicago is relatively small, and a large number of prepared hog products, nearly fifty, were examined. The actual number of sides of different animals of the different kinds and from the different sources was as follows:

	Sides.
Texas steers	3
Northern range (Colorado or Montana) steers	3
Native (Illinois and neighboring States) steers	3
Native (Illinois and neighboring States) cows	2
Texas veal	3
Native veal	3
Northern range mutton	2
Native mutton	6
Swine	3

Each side was divided into cuts in the manner usual in Chicago. In general there were 12 of each side of beef, 9 of veal, 6 of mutton, and 12 of pork.

The way of taking the samples at the slaughterhouses may be illustrated by descriptions of the method followed in the case of a side of beef.

ANALYSES OF SIDE OF BEEF—TAKING OF SAMPLES.

The thoroughly systematic manner in which the business of the great packing houses is done and the record of details is kept greatly facilitated the taking of the samples and gathering of the desired data regarding them.

The animals, on arrival at the stock yard, are sorted and grouped into pens. When they are taken from the slaughtering pen each animal is weighed, and after butchering the dressed weight is taken and a tag is attached to each side, showing the number of the group from which it is taken, date of butchering, weight, etc. After butch-

ering the sides of beef are put in a room with very low temperature and "chilled" as rapidly as possible. After they are completely chilled they are placed in cold storage, in rooms kept at a constant temperature of about 38° F. This cold-storage room is well ventilated, and great care is taken to avoid all excess of moisture. From the weights made immediately after butchering, and that at time of sale, the shrinkage of weight while kept in cold storage is known.

The side of beef, the analysis of which is given herewith, was from a so-called "Colorado" steer brought from one of the great northern ranges. It was taken from a lot of 56 steers, of which the average live weight was 1,253 pounds and the average dressed weight 723 pounds. Two men from the laboratory, one of them a member of the jury, one of Messrs. Armour & Co.'s superintendents, and two or three laborers, after wrapping themselves in heavy overcoats, went from the outside temperature of about 85° F. into the cold-storage room where the 112 sides of beef from this lot of steers were hanging. The sides were all hung upon hooks attached to trundles, which were suspended from a single rail near the top of the room. After walking through the aisles of beef and examining them, three or four sides were selected from which to choose the particular side for analysis. These were "run out" by the men and weighed, and finally this particular side was selected as fairly representing the average of the lot. This side was taken by the men to a room in another part of the cold-storage building where the beef furnished the Chicago city trade is cut up. Here the side was weighed and speedily cut into the pieces or cuts usual in Chicago retail trade. Each of the cuts was then weighed, after which the flesh was separated from the bones. Both the bones and flesh were weighed so as to give a check upon the first weighing as well as to show the proportions of edible meat and refuse. The flesh was then carefully cut into representative slices, and enough to fairly represent the cut, 4 to 8 pounds, was taken and put into a tin pail having a tight-fitting cover. After all the cuts had thus been treated the pails containing the samples were taken to the sausage department, where each sample was finely chopped by machine. The finely-divided flesh of each cut or sample was then thoroughly mixed by hand and a sample of 2 or 3 pounds in weight was put into closely covered pails and taken to the laboratory. These samples were chopped still finer at the laboratory, and still smaller portions of a few ounces were taken to be dried down to constitute the final sample. So far as concerns the pains taken to secure a representative sample, the process is analagous to that observed in selecting a sample of gold ore. It is unnecessary to say that great care and good judgment are necessary in every step of the process of sampling, from the selection of the animal to the picking out of the small portion for final drying, in order that less than a handful of the dried flesh may fairly represent from 10 to 100 pounds of fresh beef.

It may be added that the total value at wholesale of the meats thus cut up for analysis at the stock yards was estimated at nearly $600, in addition to a considerable amount supplied from the exhibits on the Fair grounds. The gift of this amount of valuable product, the not inconsiderable amount of labor of superintendent and workmen in selecting and preparing the samples and transporting them to the laboratory, and the valuable information furnished are indications of the public spirit of the firms whose names are mentioned above.

The value of the material for investigation is much greater than its commercial value as above estimated. In no other way could specimens be obtained which so well represented the products as actually sold in the different parts of the country. Even if the same quantity had been obtained gratuitously at retail markets the selection could not have been made so as to secure typical materials.

It is needless to say that the labor involved in the analyses of these specimens was quite considerable, and while from the purely scientific standpoints results of greater chemical and physiological value might have been obtained with the same labor, it is not easy to see how information of as great practical utility could have been obtained at as small expense in any other way.

DEVELOPMENT OF THE MEAT INDUSTRY IN THE UNITED STATES.

Very few people realize the magnitude which these industries have assumed within comparatively recent years; their economic importance, and the diversified methods employed in the collection, preparation, and transportation of meat and meat products.

The statistics of the manufactures of the United States Census of 1890[a] show that the largest of our manufactured products is meat; that, in other words, the value of the meats produced in the great wholesale slaughtering and packing establishments is more than that of the iron and steel, or even the flouring and grist mill products. Here are the figures for the values of products of the four chief industries in 1880 and 1890:

Values of the products of the four largest manufacturing industries in the United States.

Industries.	Value of products.	
	1880.	1890.
Slaughtering and meat-packing products[b]	$303,562,413	$564,667,035
Flouring and grist mill products	505,185,712	513,971,474
Iron and steel[c]	296,557,685	430,964,348
Lumber and other mill products from logs or bolts	233,268,729	403,667,575

[a] Census Bulletin No. 380, April, 1894.

[b] In 1890 includes 611 establishments reported as "slaughtering and meat packing, wholesale;" 507 establishments reported as "slaughtering, wholesale, not including meat packing," and 249 establishments reported as "sausage."

[c] Iron and steel for 1890 does not include establishments that continue the manufacture of the metal into a more finished product, such as wire, nails, and spikes.

FORESTS IN JAPAN.

BY

SHIKAZO SUWA.

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FORESTS IN JAPAN.

By SHIKAZO SUWA.

Fr n the remotest period great attention has been paid for the management of forests, the fair success of which has shown a wonderful fact; the people (nearly 40,000,000 in number) of Japan (one of the oldest countries in Asia), whose manner of living needs more quantity of timber and fuel than any other nation, have never suffered from the want of these valuable materials. The fact shows that there must have been and still are at present many laws referring to forest management; as, for instance, after the removal of the natural cover, the soil is never allowed to be exposed to the sun and wind by the obligation of national or local laws, or else the devastated hills or mountain lands, partly or quite absent of trees, are usually to be covered by artificial planting. But if I were to mention these laws they may fill a large volume; so that I will describe only a short sketch about some on present conditions of forests in Japan.

I. FORESTRY SECTIONS AND PRINCIPAL TREES IN THEM.

In order to manage the forests belonging to the Government, the whole extent of the Empire (Hokkaido excepted) is divided into ten sections, according to the political convenience, as is shown in accompanying map, and each section has an experimental station and a branch office under the direction of the central government forestry bureau in Tokyo.

The names of the sections are as follows: Aomori, Akita, Miyagi, Tokio, Nagano, Osaka, Hiroshima, Kochi, Fukuoka, Kagoshima. Among these sections the forests belonging to the imperial household and individual persons are widely distributed, but they are out of description in this case.

Japan grows more than 400 species of forestry trees, out of which the following will be most important for buildings, furniture, or ornamental purpose, and also for charcoal manufactures; as well as the predominating species in the country.

1. Thuya dolabrata, L. Coniferæ.
2. T. gigantica, Nutt. var. japonica, Maxim.
3. T. pisifera, Benth. et Hook.
4. T. obtusa, Benth. et Hook.
5. Cryptomeria japonica, Don.
6. Cephalataxus drupacea, S. et Z.
7. Taxus cuspidata, S. et Z.
8. Torreya nucifera, S. et Z.
9. Ginkgo biloba, L.
10. Sciadopytis verticillata, S. et Z.
11. Pinus densiflora, S. et Z.
12. P. thunbergii, Parlat.
13. P. perviflora, S. et Z.
14. P. koroiensis, S. et Z.
15. Picea polita, Carr.

16. P. alcockiana, Carr.
17. P. microsperma, Carr.
18. Tsuga sieboldii, Carr.
19. Abies firma, S. et Z.
20. A. Vietchii, Henk. et Hochst.
21. A. mariesii Masters.
22. A. brachyphylla, Maxim.
23. Larix leptolepis, Gord.
24. Podocarpus macrophylla, Don.
25. Cercidiphyllum japonicum, S. et Z.
26. Magnolia kobus, D. C.
27. M. hypoleuca, S. et Z.
28. Camellia japonica, L.—Ternstroe miaceæ.
29. Tilla cordata, Mill., var. japonica, Miq. Tiliaceæ.
30. Æsculus turbinata, Bl. Sapindaceæ.
31. Acer buergirianum, Miq.
32. A. purpurascens, Fr. et Śav.
33. A. argutum, Maxim.
34. A. spicatum, Lam., var. ukurunduense, Maxim.
35. A. parviflorum, Fr. et Sav.
36. A. dystylum, S. et Z.
37. A. carpinifolium, S. et Z.
38. A. cratasgifolium, S. et Z.
39. A. rufinerve, S. et Z.
40. A. pictum, Thunb.
41. A. trifidum, Thunb.
42. A. tartaricum, L., var. aidzense, Franck.
43. A. japonicum, Thunb.
44. A. palmatum, Thunb.
45. A. cirsifolium, C. Koch.
46. A. diabolium, Bl.
47. A. picnanthum, C. Koch.
48. Rhus vernicifera, D. C. Anacardiaceæ.
49. Cladrastic amurensis, Benth. et Hook. Leguminoseæ.
50. Sophora japonica, L.
51. Prunus pseudo-cersus, Lindl. Rosaceæ.
52. P. maximowiczii, Rupr.
53. Distylum racemosum, S. et Z. Hamamelideæ.
54. Cornus macrophylla, Wall. Cornaceæ.
55. Diospiroe lotus, L. Ebenaceæ.
56. D. kaki, L. Fil.
57. Fraxinus mandshurica, Rupr. Oleaceæ.
58. F. pubinervis, Bl.
59. Paulownia imperialis, S. et Z. Scrophulariaceæ.
60. Cinnamomum camphora, Nees. Lauraceæ.
61. Machilus thunbergii, S. et Z., var. Glaucescens, Bl.
62. Ulmus campestris, Sm., var. vulgaris, Plauch. Ulmaceæ.
63. U. montana, Sm., var. laciniata, Trautt.
64. U. parvifolia, Jacq.
65. Zelkowa keyaki, Sieb.
66. Celtis sinencis, Pers.
67. Aphanauthe aspera, Plauch.
68. Juglans regia, L., var. sinencis, Casim. Juglandaceæ.
69. Juglans Sieboldii, Maxim.
70. Platycarya rhoifolia, S. et. Z.
71. P. strobilaceæ, S. et. Z.
72. Betula alba, L. var. vulgaris Reg. Betulaceæ.
73. B. alba L. var. Tansii, Reg.
74. B. ulmifolia, S. et. Z.
75. B. bhojpattra, wall. var. Subcordata Reg.
76. Alnus maritina, Nutt. var. japonica, Reg.
77. Alnus firma, S. et. Z.
78. A. incana, Willd, var. glauca, Ait.
79. Carpinus japonica, Bl. Corylaceæ.
80. C. Larixflora, Bl.
81. Corylus peterophylla, Fisch.
82. C. rostrata, Ait. var. Sieboldiana, Maxim.
83. Quercus dentata, Thunb. Cupuliferæa.
84. Q. crispula, Bl.
85. Q. crispula, Bl. var. grosseserrata, Miq.
86. Q. glandulifera, Bl.
87. Q. variabilis, Bl.
88. Q. serrata, Thunb.
89. Q. glabra, Thunb.
90. Q. acuta, Thunb.
91. Q. gilva, Thunb.
92. Q. glauca, Thunb., forma sericea.
93. Q. phyllireoides, A. Gray.
94. Q. glauca, Thunb., forma glabra.
95. Cuspidata, Q., Thunb.
96. Castanea vulgaris, Lam. var. japonica, D. C.
97. Fagus sylvatica, L. var. asiatica, D. C.
98. F. sieboldii, Endl. var. undulata, Bl.
99. Salix mulinervis, Fr. et. Sav. Salicineæ.
100. Populus suaveoleus, Fisch.

II. Areas and Classification of Forests, Including some Wasted Lands.

(first) areas of forests.

The total area of the Government forests is estimated at 17,859,489.4 acres, and that of the devastated lands 22,362,844.7 acres. The area of forests, including some wasted lands which belong to the individual persons, is estimated at 29,269,526.2 acres, and that belonging to the imperial household at 8,476,044.2 acres.

SECOND CLASSIFICATION OF FORESTS.

The forests I refer to here are exclusively Government property, and they are classified into two kinds, as for permanent preservation and for national consumption.

CLASS A.—FORESTS FOR PERMANENT PRESERVATION.

This class of forests is again classified into two kinds, according to the different purposes, as follows:

First kind.—This kind of forests is of such nature as to be necessary in preventing the washing of the soil, checking the winds, and influencing the climatic conditions. Such forests are therefore usually found at the source and banks of rivers, foot of mountains, near seacoasts, etc. Trees and bamboos growing on such places have been counted as follows: Trees, 44,861,214 pieces; bamboos, 392,381 pieces.

Second kind.—This kind of forests is of such nature as to be kept for scenery or ornamental purposes. Such are therefore usually found in famous old places and parks. Trees and bamboos growing on such places have been counted as follows: Trees, 101,538,262 pieces; bamboos, 437,053 pieces.

CLASS B.—FORESTS OF NATIONAL CONSUMPTION.

This is again classified into three kinds, according to the nature of growing plants, characteristics of soils, etc.

First kind.—This class of forests ranks first, growing the best kind of timber trees, such as cinnamon, camphor, *Zalkoa keyaki*, some soft woods, oaks, etc. The land whose nature of soil and climatic conditions are well adapted to grow the best kind of timber trees is included in this class. To have the best conveniences for transportation is also necessary for this class of forests. Trees and bamboos have been counted, 1,136,930,443 pieces, and 1,737,371 pieces, respectively, growing in this class of forests. Besides these plants, *Edgeworthia papyrifera* Sieb. et Zucc. (Thymelæaceæ), which is specially raised for fibers, have been counted, 357,910 pieces growing in the forests of this class.

Second kind.—Forests of this class rank second, growing trees of inferior nature, and the soil and locality are much poorer than those of the last class. Trees, 449,489,584 pieces; bamboos, 1,889,239 pieces; *E. papyrifera*, 1,062,960 pieces.

Third kind.—Forests of this class rank last, growing trees of poorest nature, hardly fit for building or constructing purposes. They are usually consumed as firewood or charcoal. Trees, 657,674 pieces; bamboos, 3,012,809 pieces. Besides those mentioned above there are still many tracts of land in the different parts of the Empire which would be classified either as agricultural or forestry lands, but their descriptions are omitted here, as their research is not yet finished.

III. Crops from Forests.

The topic I refer to here is also from the Government forests. There are no statistics about the crops of the imperial household or of individual persons. The following table shows the results of the last four years and an estimate for this year:

Crops from Government forests.

Years.	Timbers for buildings, constructions, etc.	Wood for fuels and charcoal manufactures.	Total.
	Cubic feet.	*Cubic feet.*	*Cubic feet.*
1890	5,859,528.8598	27,152,308.0584	33,011,836.9182
1891	8,856,217.7632	41,793,688.8936	50,649,906.6568
1892	11,589,992.0598	40,484,159.6544	52,274,151.7142
1893	20,550,506.4172	80,907,296.9776	101,457,803.5968
1894	20,342,055.0984	76,581,763.4088	96,923,728.5072

The average yield per acre differs from 2 to 5 cubic feet in round numbers, as shown in the following table, provided the yield of this year is merely an estimate:

	Cubic feet.
1890	1.847
1891	2.834
1892	2.926
1893	5.679
1894	5.425

IV. Geographical Distribution of Plants.

In regard to the natural distribution of plants, we may divide it for convenience into five zones, under some particular names of plants familiarly known among Japanese, as follows: First zone, *Ficus wightiana* Wall.; second zone, *Pinus thunbergii* Parlat; third zone, *Fagus sieboldii* Endl., var. undulata, Bl.; fourth zone, *Abies veitchii* Heuk. et Hochst.; fifth zone, *Pinus pumila* Reg.

First zone.—This zone, extending from 30° to 31½° north latitude, lies in the warmest part of the Empire, and grows 23 particular species

of plants, such as *Pinus wightiana* Wall., *Althæa rosea* L., *Podocarpus nageia* R. Br., etc. Besides these plants about 20 species of valuable timber trees are widely diffused, both in the northern portion of this zone and in the frontal portion of the second zone.

Second zone.—This zone, extending from 31° to 36° north latitude, occupies nearly one-half of the warmer part of the country, and grows 49 species of special plants, such as *Pinus thunbergii*, cinnamon, camphor, *Quercus acuta*, *Q. cuspidata*, *Q. glauca*, etc. From the northern part of this zone up to some extent of the third zone there grow about 70 species of big timber trees.

Third zone.—This zone lies between 35° and 45° north latitude, projecting into the northern extremity of the country, so that it occupies nearly one-half of the colder regions of the country. The special plants grown in this region are *Fagus sieboldii*, *Aeculus turbinata*, varieties of maples, *Thuya dolabrata*, *Thuya obtusa*, etc., 55 species in number. From the southern portion of this zone up to some extent of the fourth zone, there also grow about 13 species of other plants.

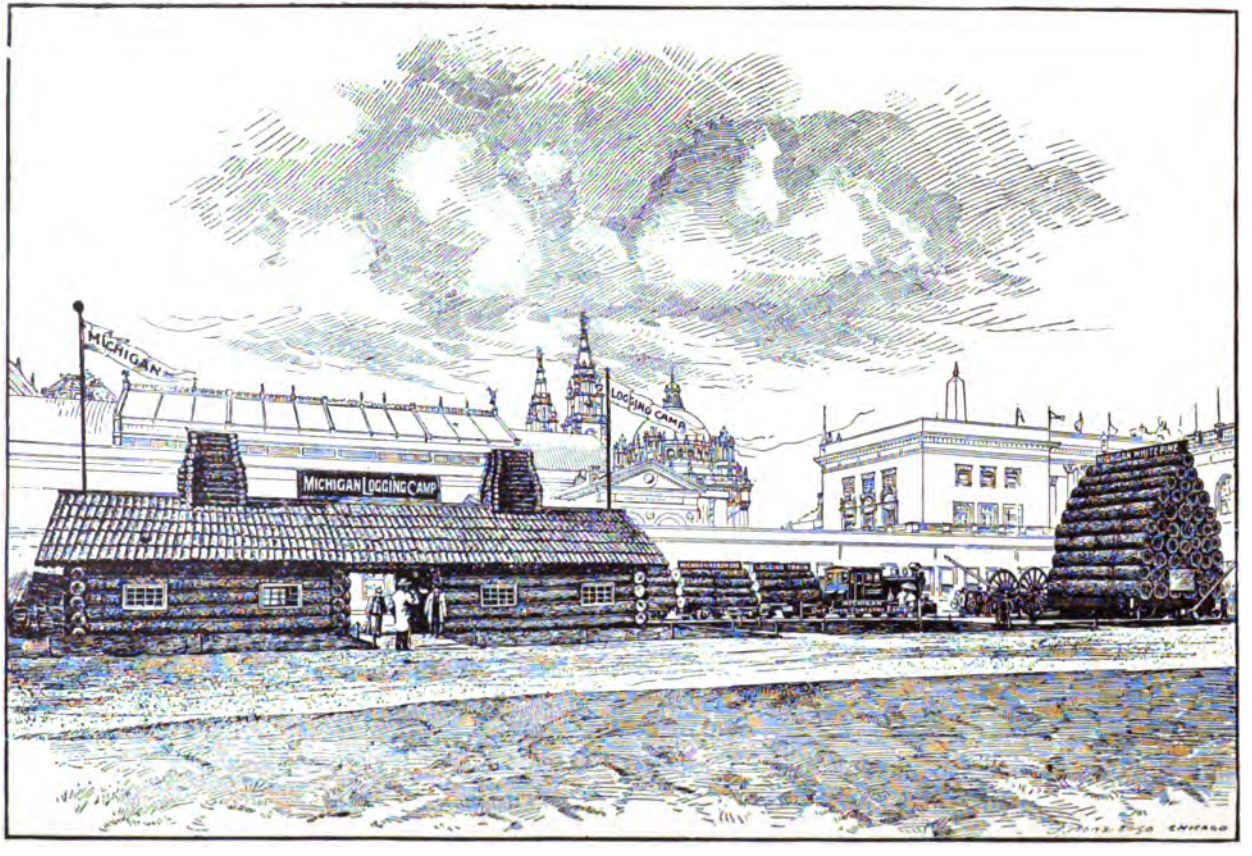
Fourth zone.—This zone, extending from 35° to 40° north latitude, and ending at the extremity of the main island or houshiu, occupies almost all of the cold mountain regions and grows only two species of special plants, as *Abies veitchii* and *Abies firma*.

Fifth zone.—This zone being chiefly applied to the high peaks and also the coldest regions of the country as far north as the Kuril Islands, the plants found here are scarcely of true shape except only one species, *Pinus pumila*, which grows usually in irregularly crooked manner under climatic influence, and is hardly of a few feet in height.

UTILIZATION OF FOREST PRODUCTS.

BY

G. SELLERGREN.



MICHIGAN WORLD'S FAIR OUTDOOR FORESTRY EXHIBIT, 1893.

UTILIZATION OF FOREST PRODUCTS.

By G. SELLERGREN, *Professor at the Technical High School, Stockholm, Sweden.*

I. LUMBERING AND HARVESTING OF FOREST PRODUCTS.

A. TREE FELLING.

It can be readily understood that the presentation, within the limits of international exposition, of the different means and methods used in the lumbering industry is a rather difficult undertaking, and that almost the only practicable way of doing this is by using photographs and models. It is only natural, then, that very few exhibitors were to be found in this group, among which are to be especially noticed Michigan, Germany, and Russia. The logging-camp exhibit of the State of Michigan attracted, for very good reasons, a great deal of interest, and might be said to have been the most unique, characteristic, and, in its way, complete arrangement on this side of the grounds.

It might reasonably have been expected that several modern appliances for felling trees should be represented, but, on the contrary, it appeared that the tool mostly in use for this purpose is the ancient ax. As regards this simple and efficient tool it will be curious to observe how many different opinions exist among the workmen concerning the shape of the handle. It has almost grown into an axiom that a forging sledge ought to have a straight handle, an ax a curved one, depending upon the kind of motion of the right arm in lifting and lowering the tool. The fact still seems to be that many a forester prefers to work with an ax having a straight handle. A rather modern style is represented by the so-called double-edged ax (fig. 1), which tool will last longer without sharpening, having two edges, though it might be assumed that it is more difficult to handle, as the head, compared to that of an ordinary ax, has too much "overweight," due to the fact that the center of gravity is situated in the middle of the eye instead of below this place.

The want of a really efficient machine which will effect a substantial economy over the ordinary and, in many cases, tedious process of felling and crosscutting trees by the ax or handsaw has caused a great many attempts to achieve this result by the employment of steam power. Almost all the machines invented for this purpose have failed,

in consequence of being so complicated and troublesome to adjust that the time expended in moving them from tree to tree, and preparing them for work, has more than counterbalanced any saving which they effected when actually cutting. This is no doubt the reason why no machinery for tree felling was exhibited, though several of them, mostly driven by steam, have been lately introduced into the market. The only tool of this kind exhibited was a folding sawing machine, manufactured at 241–249 South Jefferson street, Chicago, very similar in construction to the Ellis combination sawing machine. These machines (fig. 1) consist of a saw blade, guided by a roller and driven by means of a handle, which can be adjusted at any angle, thus making it possible for the workman to keep a more convenient position during work. It can easily be converted into a crosscut saw for cutting off logs on the ground. On the whole, this tool seems worthy of commendation, having the advantage of being light and easy for one man to carry.

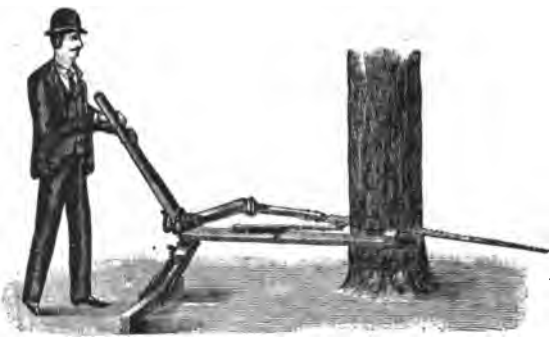


FIG. 1.—Tree feller.

B. TRANSPORTATION.

The different methods of transporting timber from the places where it is cut down to the sawmill or other place for mechanical manipulation must naturally depend upon the local topographical conditions, and thus we find that each country has adopted its own plan for this purpose. In the large forest districts of the United States, where the ground in some places is level and swampy, in others mountainous and crossed by streams, many different methods of transporting the lumber from the forest must be resorted to, among which several have attained a high degree of perfection, rendering them well worthy of being introduced abroad. In order to get a clearer view of the more systematical methods for transportation, we will consider separately those using railways, cableways, and waterways or streams.

Logging by rail has of late years been adopted to a great extent. Originating in the State of Michigan, this method has lately been

extensively introduced in other States, especially those in the South. Until within a comparatively few years the mode of logging, both in the pine and hard-wood forests, was done wholly by teams. In the Northern States the lumbermen usually conducted their operations in the winter seasons, as better roads could then be maintained with snow and ice than by means of dirt or corduroy. By the adoption of this system the nine months of inactivity during the spring, summer, and autumn, with their resultant loss of interest on investment, deterioration upon idle equipment, and expense of caring for stock, etc., has been eliminated from the cost of production.

The mode of logging by rail differs in different places, and is governed entirely by the varying requirements of the lumbermen. According to information received from Mr. J. H. Roberts, superintendent of the Michigan forestry exhibit, the general rule is to make use of convenient and available banking grounds upon lakes or streams, where sufficient depth of water will also admit of floating or driving of the logs. A base of operations thus established, the roads penetrate the forests

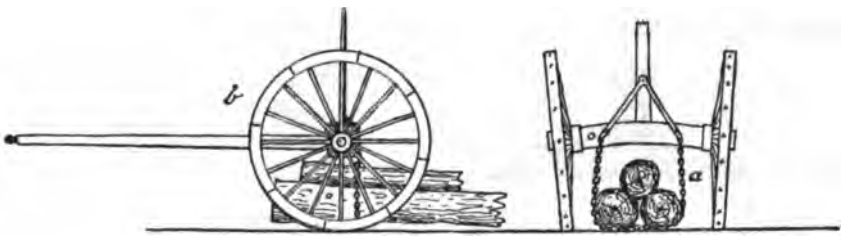


Fig. 2.—Logging cart.

at as nearly a tangent line as the formation of the country will admit, without too great a cost of grading, filling, etc. After entering the timbered sections, spurs or sidings are constructed, leaving a distance of some 400 feet between each siding and the main track. Skidways are constructed at convenient distances for the loading of the cars, and upon these are skidded the logs between the sidings and the main line. After the cutting has been completed, these sidings are removed to other desirable stations adjacent to the main line, and this operation is repeated until all the timber has been harvested. The matter of grades and alignment of such roads are not by any means serious obstacles; steep grades are not considered impracticable, even when they attain a maximum of 8 per cent, and curvatures of 10 to 20 degrees have been successfully operated upon. The roadbed or line, after its location has been decided upon, is usually cut out or cleared about 14 feet in width. Any trees or timber of a merchantable quality found upon the same are cut the required length and skidded upon suitable and convenient skidways and then remain until trains are operated, when they with others are hauled to their destination,

the timber required for ties or stringers in the construction of the road being made from any suitable timber found upon such "right of way." All trees that are growing upon space to be occupied by track are cut and stumps removed; trees growing outside of such space, and within the 14-foot right of way, are sawed down close to the ground, so that the stumps left will not interfere with or obstruct the operation of the road. Then a grade line is established, and cuts or fills, in shape of side casting or log filling, are resorted to in order to bring the roadbed to the established grade.

The total cost per mile of such a railroad is estimated at about $3,000, and the approximate cost of equipment to operate 10 miles of logging railroad would be about $8,000, including 20 logging cars at $200 each, and 1 locomotive at $4,000.

In transporting the logs to the loading cars a two-wheeled car, of the appearance shown in figure 2, is sometimes used. When in use, the wheels are backed directly over the logs, the long tongue or shaft being thrown into a perpendicular position. The logs are then encircled with a heavy chain *a*, attached to the axle of the wheels, whereupon the horses move forward a short distance, thereby bringing the

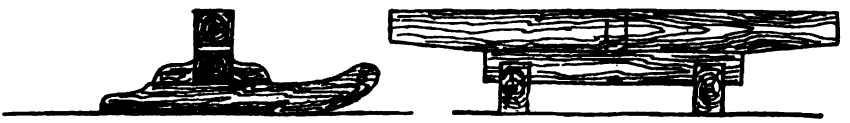


FIG. 3.—Logging sledge.

tongue down to a horizontal position *b*, thus swinging the logs up several inches from the ground. The logs are then securely bound, the horses attached to the end of the tongue, the whole load, consisting of three to five logs, then being easily moved through the forest. The wheels are strongly built, being made entirely of oak, and are 10 feet in diameter and 6 inches wide at the rim.

In the winter heavy sledges are used, shown in figure 3 and exhibited at the Michigan logging camp, as well as the above-mentioned car. The runners are made of white oak, 5 feet apart, and joined together by means of a strong beam, or bunk, 14 inches square and 16 feet long. Two such sledges were tied together with two chains crossing each other and going from the middle part of the front sledge to the front part of the back sledge. In order to facilitate the passage through curves, the bunk is movable on a strong vertical pivot. As an example of the great loads sometimes carried by these sledges, it may be mentioned that not less than 51 logs, 2 to 3 feet in diameter and 18 feet in length, representing 36,000 feet of lumber, were drawn by one team of horses through the forest. This load on the two sledges was exhibited at the logging camp. It had a weight of 144 tons and a

height of 33 feet. It follows of itself that the ground must be covered with ice, the road carefully made, and the sliding surface of the runners sufficiently large to prevent their sinking under the heavy load.

The next operation is to load the logs upon the cars. The loading crew generally consists of four men, one of whom (the loader) stands upon the car or load. Aided by the handy cant hook, he has to display a great deal of skill and judgment, as the logs are rolled up on the skidway, in arranging them in such positions as to insure the load being large and safe. Another man attends to the logs on the skidway (inclined plane, consisting of two logs with their lower ends on the ground, in about 30 to 35°), and arranges them for the horse, while the other two men are occupied, one at each end of the logs, to guide them safely as the horse pulls them up the skids. The logs are thus moved by means of a chain and a pulley fixed in a convenient position. The loading operation is thus made a comparatively easy and speedy one. The cars will average in load about 2,500 feet each, log scale, while the time occupied in loading them will not average over two and one-half minutes each.

The locomotives ordinarily in use on these railways, and for this purpose, are somewhat different in construction from the usual types. Three such logging locomotives were exhibited, one made at Baldwin Locomotive Works, Philadelphia; one from H. K. Porter & Co., Pittsburg, and one from Lima Locomotive Works (Shay's patent). The first named had two coupled driving wheels, one pair of smaller carrying or truck wheels in front and one pair behind (double-ender model). It used wood as fuel, and had a gauge of 4 feet 8½ inches. Among its principal dimensions may especially be mentioned: Diameter of cylinders, 14 inches; stroke of piston, 24 inches; diameter of driving wheels, 44 inches; diameter of truck wheels, 24 inches; inside diameter of boiler, 44 inches; thickness of boiler plate, ⅜ inch; total heating surface, 721 square feet; working steam pressure, 130 pounds per square inch; total weight, in working order, 72,130 pounds; length of engine over all, 31 feet.

In front of the boiler was a hauling apparatus, which naturally would be of great use in the forest, and the chimney had a fire extinguisher. On the whole, this locomotive seemed to answer well its purpose, being strongly and practically built, with the movable parts well protected.

Shay's locomotive was built with special reference for work on heavy grades and sharp curves. It differed in its construction entirely from the former type, the driving wheels being placed four in front and four behind, all of them driven by conical tooth wheels fixed on two parallel shafts, one on each side of the locomotive. These shafts received rotary motion by means of cranks moved by the pistons in the steam cylinders, of which three were placed in a vertical position on

each side and on the middle part of the locomotive. The two trucks were movable on vertical pivots, in order to pass curves, and the two driving shafts were, for this purpose, made in several parts, connected by universal joints. Thus arranged, the locomotive was said to overcome grades of 10 per cent and curves of 63 degrees. A few remarks might possibly be made against the practicability of this construction;

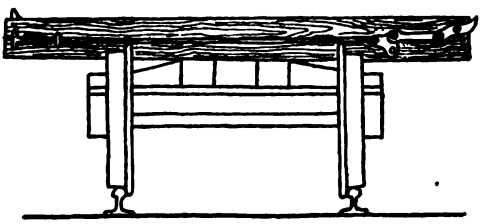


FIG. 4.—Dog attachment.

as, for instance, that all the movable parts were placed outside, exposed to blows from timber or stray wood; that the eight pairs of conical driving wheels absorb a great amount of power; and that, by breaking, a pair might easily get out of working order, thus rendering the whole locomotive for the time useless. Its principal dimensions were: Diameter of cylinders, 11 inches; stroke of piston, 12 inches; diameter of the (8) driving wheels, 32 inches; diameter of boiler, 44 inches; length of the (106) fire tubes, 96 inches; diameter of the fire tubes, 2 inches; capacity of tank, 1,800 gallons; total wheel base, 27 feet 4 inches; length over all, 39 feet; weight, in working order, 80,000 pounds; fire box, 73 inches long, 40 inches wide, 52 inches deep.

FIG. 5.—Deer-foot toggle binder.

The logging cars in use on these railways have small wheels (24 inches in diameter) to facilitate the loading, and usually have their couplings so arranged that the distance between the cars may be adjusted to suit varying lengths of logs. The frame is provided with four dogs to keep the bottom logs from rolling. A novel and practical arrangement, shown on one of the cars, consisted of the patented Thompson self-locking dog attachment (fig. 4), by means of which the dog could easily be raised or lowered from the opposite side of the car

by means of a connecting rod. This is a simple and cheap, but most effective, device, which enables the quick and safe unloading of a train load of logs. The track opposite the dumping place is built with one rail lower than the other, so that the car has a sufficient side incline to cause the logs to roll off by force of gravity upon the release of the dog, which is absolutely self-locking when standing upright, but may easily be pulled down by means of the connection to its lower arm.

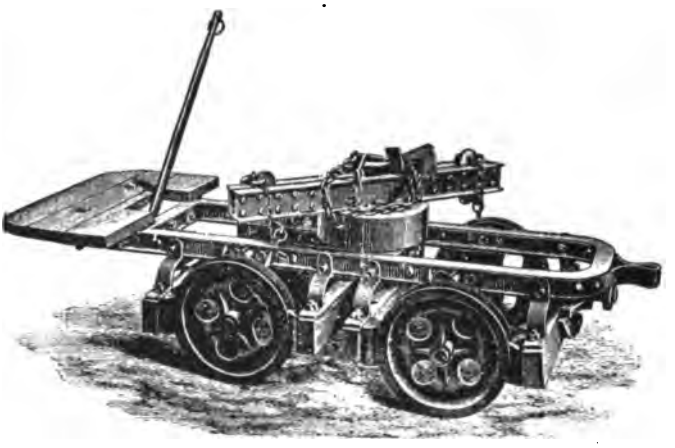


FIG. 6.—Forest railway logging car.

It is in practical operation on many of the large logging railways in the United States, notably by the Missouri Lumber and Mining Company at Grandin, Mo., and effects great economy in the handling of round timber by rail.

Another arrangement for chaining logs together on the car was the so-called "deer-foot toggle binder," illustrated in figure 5, which seemed to be both safe and practical. The Russell Wheel and Foundry Company, of Detroit, Mich., exhibited logging cars of practical design and strong and solid construction, having wheels 26 inches in diameter, journals 3¾ inches by 7 inches, and a total weight of 12,000 pounds.

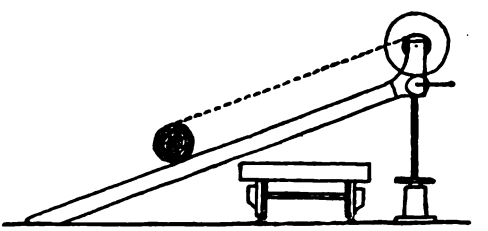


FIG. 7.—Skidding apparatus.

The only country in Europe where railways are used on a somewhat large scale for forestry purposes is Germany, whose exhibit displayed several models of arrangements more or less in use in that country. The railway system is the narrow-gauge and the cars are mostly constructed of iron or steel, as shown in figure 6, thus differing from the wooden frame used on the American cars. Underneath the

frame runs a brake shaft, by pulling on which the blocks are pressed against the wheels. Figure 7 shows a skidway, the inclined plane of which can be changed to suit the loading car below. The log is hauled up by hand, whereupon the skidway is lowered by turning the two strong vertical supporting screws until the log rests on the car.

It may be of a certain interest to compare the cost of building different kinds of roads for forestry purposes. According to information from Germany and from experience there gained, an ordinary "corduroi" road would amount to $1 per mile, a gravel road $1.35, a macadam road $2.35, and a movable railroad track $1.17, all of the same width, or 13 feet.

If the logs are to be transported over swampy grounds another method has proved itself to be practical, namely, the using of cableways, which, since 1885, have been successfully in operation in several cypress forests, among others by the Ruddock Cypress Company, of New Orleans; Lutcher & Moore, Boyden & Wyman, et al. As this system seems to have several points of excellence, especially Butters' patent log skidder, a somewhat more detailed description of

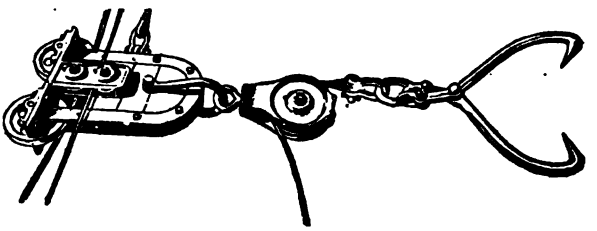


FIG. 8.—The skidding carriage.

the same might be both of interest and use, especially for foreign countries, where this comparatively easy mode of transportation is almost unknown.

A wire cable strong enough to carry two or three logs is suspended between two trees, of which one (the head tree) is chosen near the place for log deposit, and the other (the tail tree) is situated at a convenient distance, traversing the space where the logs are picked up. The cable is fixed about 50 feet from the ground on the head tree and 25 feet on the tail tree, if the ground is level. On this cable runs the skidding carriage (fig. 8). The outhaul rope (see fig. 9), which passes from the hauling drum over a sheave of the head tree back to the tail tree, running there through a sheave again and returning to the carriage, passes through a double block on the side of the skidding carriage. To the lower end of this carriage is attached another sheave, through which runs a hoist rope with a set of special logging tongs. The double cylinder engine has four hoisting drums, fitted with Beekman patent frictions. Each drum is thereby perfectly independent of the other in its action. The front drum is arranged to operate the outhaul rope; the drum next behind operates the hoist rope of the

main cable; the two rear drums, which are arranged side by side, are used for operating the loading cable, one for hoisting and one for

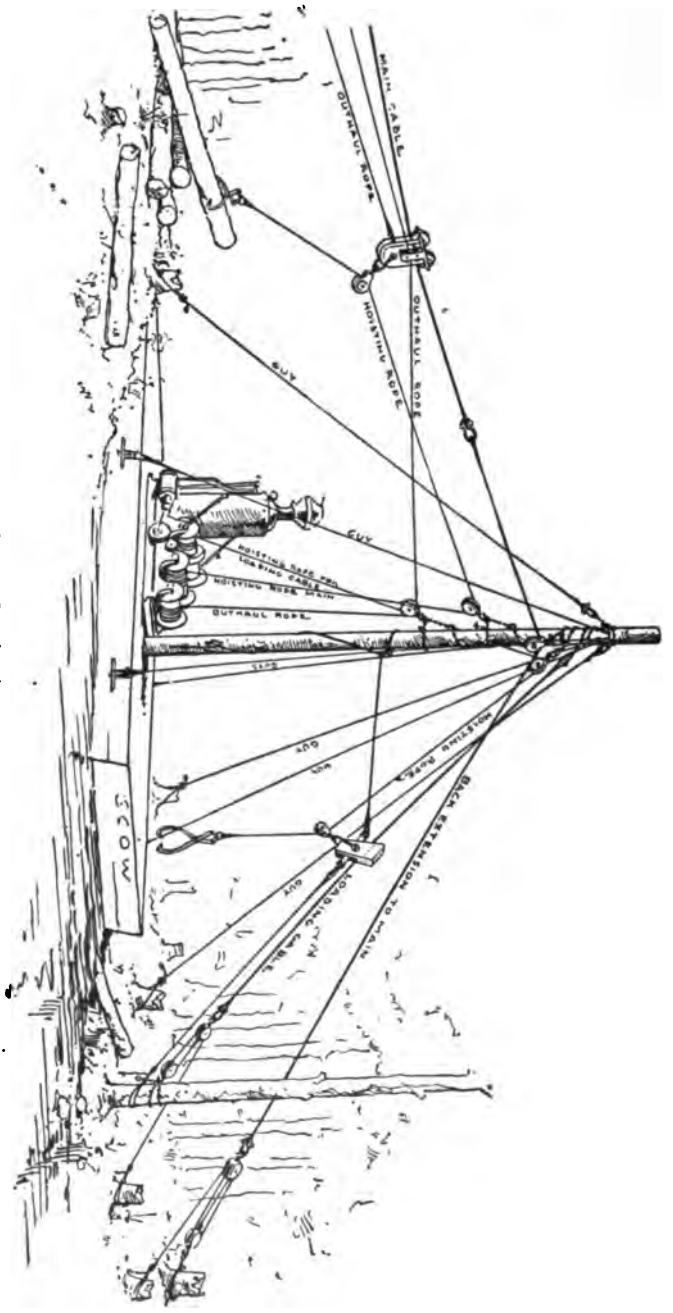


FIG. 9.—Logging in swamps.

hauling out the carriage; or each drum may operate a hoist rope, thus running two loading cables at once. The engine is either of 40 or 50

horsepower; the drums are 24, 30, 18, and 21 inches, respectively, in diameter. The vertical boiler is 53 by 108 inches in diameter.

The rigging is put on one tree while the other is being used, so that as soon as the logs around one "setting" have been loaded the engine is moved to the next "setting" with the least possible delay.

The loading carriage, visible on the right side in figure 9, in performing its function does not need to be moved very much on the loading cable, hence it is not fitted with wheels, as is the skidding carriage on the main cable, but rests on wood set upon end. The block and the loading hoist rope are similar to those on the skidding carriage.

When the apparatus is in operation the skidder receives its load by the tongs being hooked into the log near the end; if the log is light, additional tongs are secured to other logs, the hoist rope engaging all of them. This rope is wound in by the man in charge of the hoisting drum, until the logs are gathered altogether and the ends hoisted well in the air. Then the hoist rope is drawn in at the same speed that the man at the engine allows the outhaul rope to be paid out, and this

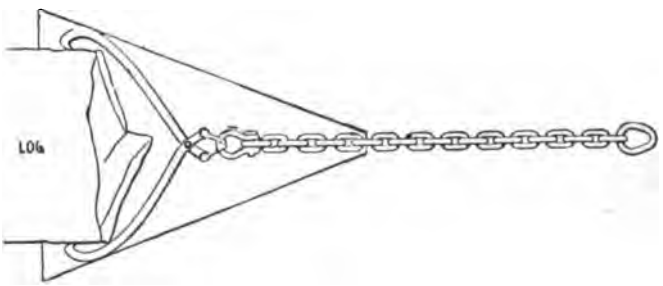


FIG. 10.—Diagram showing log tongs, chain, and cone.

gives to the logs their horizontal motion. If in their passage toward the head tree, stumps or other obstructions are encountered, the man in charge of the outhaul drum holds it by the brake for an instant, until the man at the hoisting drum has hoisted the ends of the logs high enough to clear the obstruction, whereupon the logs can be drawn toward the head tree. As soon as the logs are deposited as near as practicable to the head tree the skidding carriage is hauled back to receive another load. The tongs on the loading carriage then pick up the logs, one by one, and loads them on the cars.

In swampy places the engine with its hoisting drums may be placed on a scow, floating on a stream, in which case the mast on the scow serves in place of the above-mentioned head tree. The logs are drawn and thrown into the water or canal, the skidding carriage drawing the logs to the bank and the loading cable dragging them from the bank into the water or loading on to a scow.

Another simple and rather original system for the transportation of logs in forests consists in hauling them on the ground; and in several

places, as in the cypress swamps of Louisiana, this (Baptist) system has become popular. It involves the use of a powerful double drum winding or pulling engine, employing two steel cables about 1 inch in diameter rigged on the tail-rope plan, with a sheave secured in the woods 3,000 feet from the engine. To the ends of these cables are attached a chain and tongs, and over the same a steel cone (fig. 10). A third cable about three-fourths inch in diameter and 3,000 feet long connects the ends of the pulling cables. When a log is being pulled in by one cable the other is being drawn out into the woods. In this manner the logs can easily be drawn in without becoming imbedded in the ground or caught by obstructions.

The above-mentioned different appliances for logging by cable ways are manufactured by the Lidgerwood Manufacturing Company, New York.

In countries abundant in waterways, such as streams, rivers, or canals, the transportation of the logs from the forest to the sawmill will be greatly facilitated. Still it must always depend upon the character of the stream whether or not it may be practically used for this purpose; and in any case several arrangements become necessary to prevent the logs being stopped in the course, to lead them into the right direction, or to assist their passage through falls or rapids, etc.

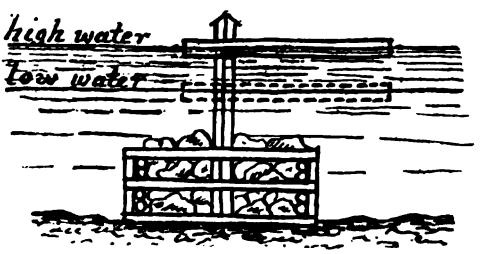


FIG. 11.

The floating system is highly developed in several countries in Europe, among which may be especially mentioned Sweden and Russia, and in the former country this manner of transporting logs is more common than others. In rivers and smaller streams the logs are transported one by one, while on lakes they are collected in bundles for easier handling.

Figures 11 to 15 illustrate the use of these waterways in Sweden. In the larger navigable rivers there the law requires that an open channel be kept in the middle (king's way), where steamers and boats can go without being troubled by the logs. In small rivers or streams the existence and necessity of such a way is very often disputed, which causes a great deal of litigation between the owners of the land, especially in building weirs and flood gates. In order to guide the logs during their passage, to prevent them from entering the king's way or lodging on the shore, there is a continuous row of logs, having their ends linked together, floating on the water, and by suitable means fastened to the bottom, so as to keep a steady position. Two different arrangements for this purpose are shown in figures 11 and 12. Accord-

ing to the former method a strong beam stands upright in a wooden box filled with stone and placed on the bottom. The top of this beam rises above the surface and passes through a hole in the horizontal floating log, which thus will be able to rise and fall with high and low water. In some places the vertical beams are simply driven down in the bottom. The other arrangement, which is perhaps most in use, is executed in such a manner that the floating logs in certain places, such as bends of the river, etc., are fixed to large stones on the bottom by means of logs hooked or chained together. Figure 12 shows two such connections to the bottom, but in many cases one will be sufficient, as

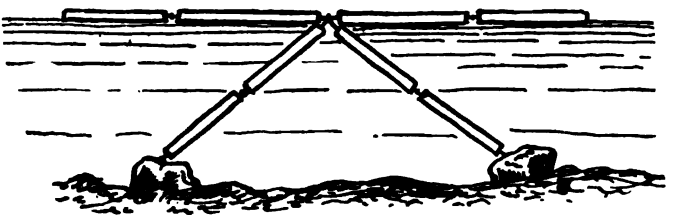


FIG. 12.

the flood usually keeps it in proper position. Instead of fixing the logs to a stone there might be built a wooden box, which is afterwards filled with stone and sunk. This method is preferable in deep water. The difference between high and low water in the Swedish rivers never exceeds 20 feet.

In some cases it will be enough to fix the end of the upper log at a strong support and let all the logs in the chain below have a free motion in the water, only kept in place by the power of the stream. If, in this case, it should be necessary to guide the floating timber in

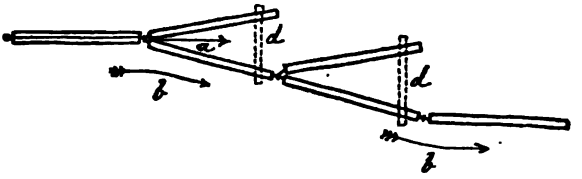


FIG. 13.

an oblique direction, as is indicated in figure 13, where the water runs in the direction of the arrow a and the timber is guided as the arrows b are pointing, then two logs are fixed together at a certain angle by means of crossbeams d, which latter are thus resting above the surface of the water so as not to interfere with its motion. By a very simple and ingenious device the guiding line of the logs might be changed to any direction, as the diagram, figure 14, shows. If the logs forming the angle are of different length and the water running in the direction of the arrows c and d, then the power of the water will cause the system to turn round the point o, until it balances itself. Thus, if

a and b signify the lengths of the logs, equilibrium will enter, when $p.\ a=p_1\ b$; but $p=q$ sin v and $p_1=q$ sin w; consequently: $\frac{a}{b}=\frac{\sin w}{\sin v}$;

When there are falls or strong rapids in the river, as is very often the case with Swedish rivers, especially in the forest regions in the north, the logs are passed by means of sliding ways or chutes built of rough logs in V-shape, and resting on wooden supports, or, if the cost is not too large, a special canal is constructed around the rapids, and the logs passed by means of sluices. As a peculiarity it may be mentioned that

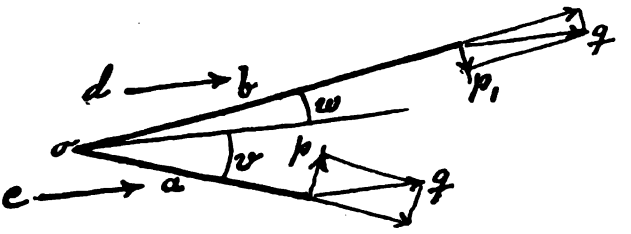


FIG. 14.

there were exhibited in the forestry exhibit of Japan several paintings on silk, representing in the characteristic Japanese manner different means and methods of transporting timber in forests, and amongst other interesting features there were represented canals with sluices and V-shaped slideways, built of timber in the same manner as those used in Sweden, and said to have been used in Japan since ancient times.

In figure 15 is represented the general manner of building these waterways; a is an opening for smaller boats, and b is a movable float-

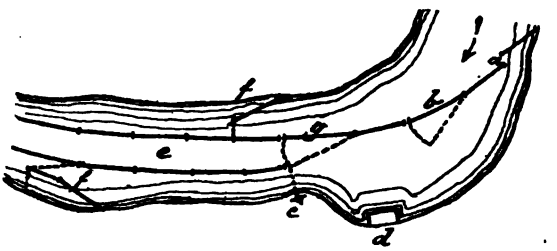


FIG. 15.

ing log, which is intended either to lead the timber on the right side (mostly during the day) or on the left side, as the dotted line indicates, when some of the logs pass through the opening. The log g can also be moved in the dotted position by means of a winding apparatus, c, fixed on the shore, and is kept in the drawn position by the force of the water. When b is open g must be shut, so that the logs may not enter the king's way, e, which is intended only for steamboats and logs tied together in bundles or rafts; d is a steamboat pier and ff are two places where the floating logs may easily be stopped, so as not to crowd

the assorting places below. Each log is stamped in several places to indicate the owner, and when the logs arrive at the assorting places they are separated and drawn into boxes ("bose") or partitions, each owner having his own timber box.

Transportation on lakes or seas is mostly done by rafts, which may be built in different ways, as illustrated by figures 16, 17, and 18. Figure 16 shows the ends of the logs drawn backward, thus keeping an inclined position, whereupon the logs are tied together by iron chains or ribs, mortised into smaller logs or tree tops. In figure 17 the logs are kept together in horizontal layers of 200 or 300 pieces; these small rafts are then tied together, the whole raft thus consisting of 5,000 to 10,000 logs. The dimensions of the raft for transportation on canals is ordinarily kept at 70 by 15 by 3 feet.

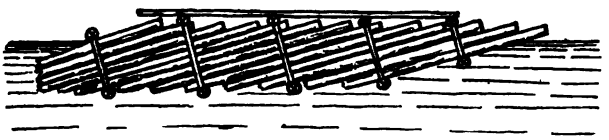


FIG. 16.

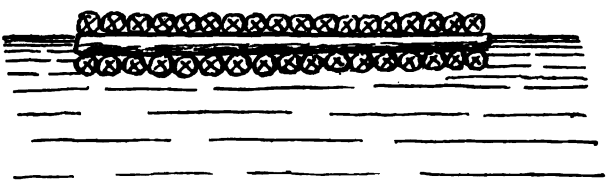


FIG. 17.

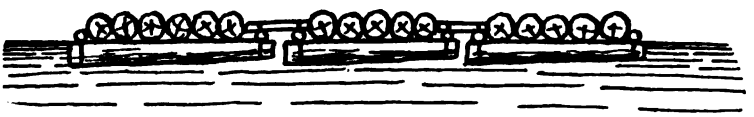


FIG. 18.

In the Russian forestry exhibit was shown a model of a raft as used in that country. It consisted of several smaller rafts (fig. 18), each built of two horizontal layers, crossing each other at right angles, and joined together by means of short pieces of timber and wooden strings. A raft thus built contains about 500 logs.

IV. Drying and Seasoning of Wood.

Much thought and inventive genius has been spent in finding out an expeditious and effective manner of artificially seasoning wood, and the most common method for this purpose is to pile the timber, after being cut to suitable sizes, in drying chambers, where the moisture is gradually taken out by means of superheated air. The general rule in this pro-

cedure is that the wood must not lose all its moisture, but retain about 8 to 10 per cent, otherwise it will be brittle. Further, this drying must be done slowly and at a lower temperature in the beginning, varying from 150° and 200° to 250° F., this temperature, as well as the time, depending upon the nature of the wood. Continuous change of air is necessary. The drying chambers generally in use are heated by a system of pipes through which steam is circulating. The differences in the systems depend largely upon whether the dry air is taken in at the top or at the bottom of the chamber. The former is the case in the older systems; the heated and dry air passes downward through the timber, spends its evaporating heat in absorbing the moisture, is thereby getting cooler and at the same time heavier, and passes out through the floor. The objection to this system is that there is no

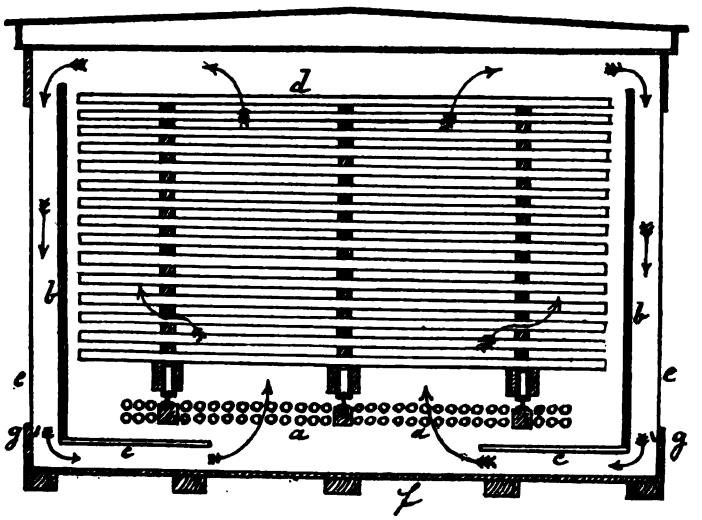


FIG. 19.—Drying kiln.

current, which consequently must be caused by artificial means, as a fan or chimney. In the other and more rational system the heated air passes from the floor upward, but in order that the air, after becoming saturated with moisture, may continue to rise, heat must be supplied, which purpose might be obtained by placing steam pipes at different places between the floor and the roof. Thus, the current of drying air passes out through the roof according to the physical law that moist air of a certain temperature is lighter than dry air of the same temperature. The only thing necessary, then, is to keep the air at the same temperature in all parts of the chamber.

A rather novel system of wood drying was exhibited, which always used the same quantity of air, circulating in certain directions. This drying kiln is shown in cross section in figure 19. It consists of a

chamber, having double walls *b* and *e*, and double floors *c f*, the inner floor being open in the middle. The outer walls *e* are made of brass plate and serve as condensers, the inner walls *b* are double with an isolating substance between. The heat is supplied through the pipes *a*, placed above the opening in the floor, steam or hot water passing through the whole system. Inside the kiln are iron rails on which the lumber carriages *d* are run. The principle for the working consists in the air circulating as shown by the arrows; that is to say, the air being heated by the pipes *a*, rises and passes through the lumber, absorbing its moisture, passes down between the walls *b* and *c*, where it is cooled by contact with the condensing plates upon which much of its moisture is deposited, and perfectly freed from moisture it passes between the floors and becomes heated again. The condensed water trickles down the plates and is conveyed out of the kiln by means of small gutters on the inside. When the air again enters into the kiln through the pipes *a*, it is still so tempered with moisture that no absolutely dry air comes in contact with the lumber, except at the dry end of the kiln. This circulation goes on continuously until the seasoning is complete. By this process the lumber is dried in a moist air and at a high temperature. The humidity of the air is so gradually and effectually lessened that warping and checking are considerably reduced; the continued use of the same body of air, without access of cold currents, saves a large part of the heat and makes the whole system economical.

These kilns are manufactured by A. H. Andrews & Co., Chicago. The model exhibited had large sliding doors at both ends of the chamber, the doors being balanced and moved up and down. The lumber carriages are introduced at one end and taken out at the other, when the wood is sufficiently dry. A good feature in the arrangement is that the heat increases at the back end of the chamber. This is done by placing a greater number of steam pipes at this end. By drying the fresh lumber at a lower temperature too quick drying, case hardening, and warping is prevented; while as the wood gets drier the carriage is pushed forward, where the temperature of the air is higher, whereby the whole process is done faster.

An automatic steam fire extinguisher is arranged at the ceiling or floor, plugs or valves of a fusible metal being melted down when the temperature increases to a certain maximum, thus causing steam to escape into the chamber and extinguish fire.

Taken on the whole, this system of drying and seasoning wood seems to have several advantages over those ordinarily in use, which will make it well deserving of introduction in foreign countries. That it already has gained great confidence is shown by the fact that more than 300 Andrews drying kilns are said to be in use in the United States. It may be added that the temperature for drying hard wood is kept at about 160° F., for soft wood (pine) about 200° (sycamore takes about

170°, poplar 190°, Southern pitch pine 200°, etc.). The thickness of the brass plate is about 22 B. W. G. The time employed for drying oak is four to five days, for yellow pine three to four days, and the steam necessary amounts to 1 horsepower per car of 4,000 feet lumber. The heat in the kiln increases about 1° F. per inch.

II. Preparation of Lumber for the Market.

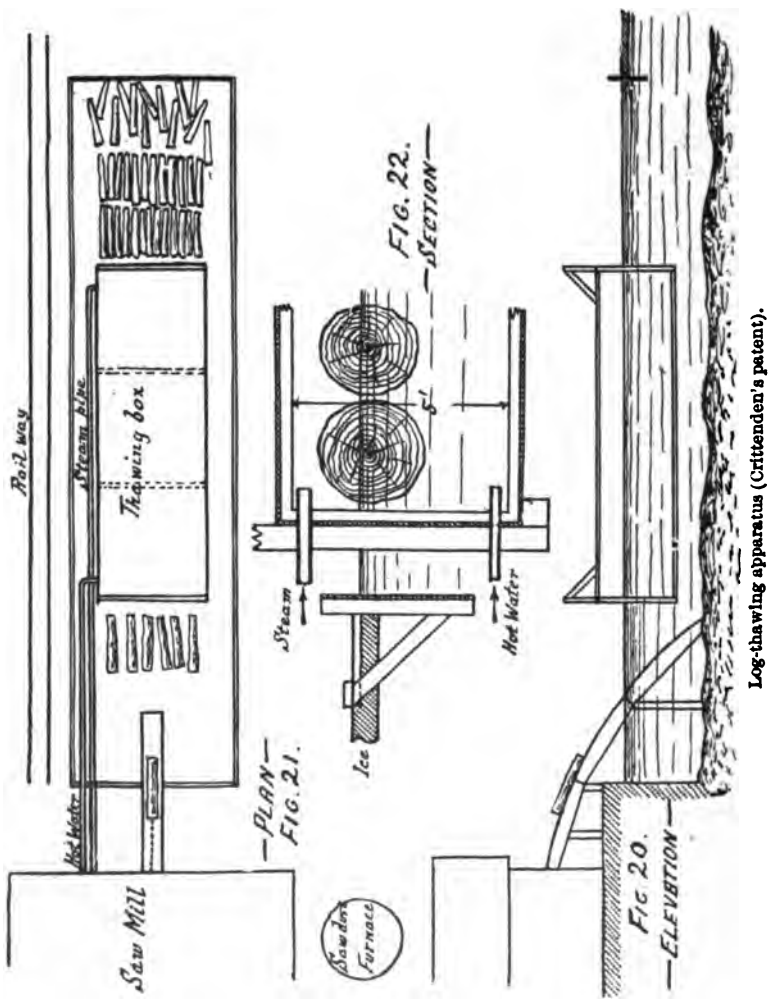
There may at first be said a few words about timber measurements, which vary a great deal in different countries. In the United States, Canada, and partly in Mexico logs are sold by the thousand feet B. M., the unit of which is a piece 12 inches square on the surface and 1 inch thick, and this rule is invariable in all thicknesses above 1 inch. But all thin (under 1 inch in thickness) lumber or veneer is measured by the square feet of surface, i. e., by the superficial foot. In Europe, on the other hand, the unit of measurement is the standard, with the higher denomination standard hundred, consisting of 120 pieces of the standard. Thus, for instance, a Petersburg standard has a dimension of 12 feet by 11 inches by 1½ inches, and is equivalent to 16½ feet B. M.; a Christiania standard has a dimension of 11 feet by 9 inches by 1¼ inches, equivalent to 10$\frac{5}{16}$ feet B. M., and a London standard has a dimension of 12 feet by 9 inches by 3 inches, equivalent to 27 feet B. M.

The Russian exhibit in the forestry building contained several samples of merchantable lumber in various sizes, exhibited by Th. Pychlau, Riga, owner of a sawmill producing from 12,000 to 15,000 Petersburg standards annually. The deals and boards are shipped in lengths of 10 English feet and upward, averaging 16 feet in length. Riga is the center for an extensive export, mostly to England, and its sawed goods are usually classified in three classes: Crown quality must be sharp-edged, a few small knots being tolerated; half crown has some wane allowed, with a moderate quantity of sound knots; third quality has wane and larger knots allowed. The brand is T_1P for crown, T_2P for half crown, and T P for thirds. The total Riga export of sawed goods amounts to about 100,000 Petersburg standards annually, principally white, but of late also of red pine. Russia also exhibited railway sleepers, or ties, of red pine, 9 feet by 10 inches by 6 inches, and oak staves, different classes, such as Tonovka, second class, length 42 Rheini. inches, width 5 inches and thickness 2½ inches; Pipovka, etc., all quarter-sawed, as is generally the case with this kind of goods. These staves are mostly sold by the "heap," comprising 180 pieces and containing 46.66 English cubic feet.

The rules in use for the reduction of round logs or timber to cubic feet or to feet B. M. are numerous. The "string" or "caliper" measure is mostly in use in Europe, whereas in the United States the Doyle, the Scribner, and the "Lumberman's Favorite" rule are generally in use. The following figures will give a comparison

between these three rules for obtaining the product of a log in feet B. M. of sawed lumber:

Diameter of log	20 inches.			30 inches.			40 inches.		
Length of log	12 feet.	20 feet.	30 feet.	12 feet.	20 feet.	30 feet.	12 feet.	20 feet.	30 feet.
"Favorite"	186	308	462	474	790	1,185	870	1,450	2,175
Doyle's rule	192	320	480	507	845	1,266	972	1,620	.....
Scribner's rule	210	350	.....	493	821	.....	908	1,505	.....



As will readily be seen from these figures, the "Favorite" rule, which has increased in popularity within a few years past, gives the smallest result in feet B. M., whereas Doyle's rule favors the larger, Scribner's the smaller logs.

A model of a rather novel arrangement was exhibited for use in connection with sawmills, namely, a log-thawing apparatus (Crittenden's

patent), seen in plan and elevation in figures 20 and 21; also a cross section in somewhat larger scale is shown in figure 22. In northern countries, where difficulties will arise in handling logs in winter, this invention might prove very useful.

It consists of a large wooden box about 300 feet in length and 50 feet in width and provided with a door at each end. This box is floating on the water, about half its depth being above and half below the surface. The logs enter this box at one side and are taken out at the other after being thawed. The temperature of the water and air inside the box is always kept above the freezing point by means of a pipe letting in exhaust steam at a point above the water, as seen in the cross section, figure 22, and another pipe letting in hot water below

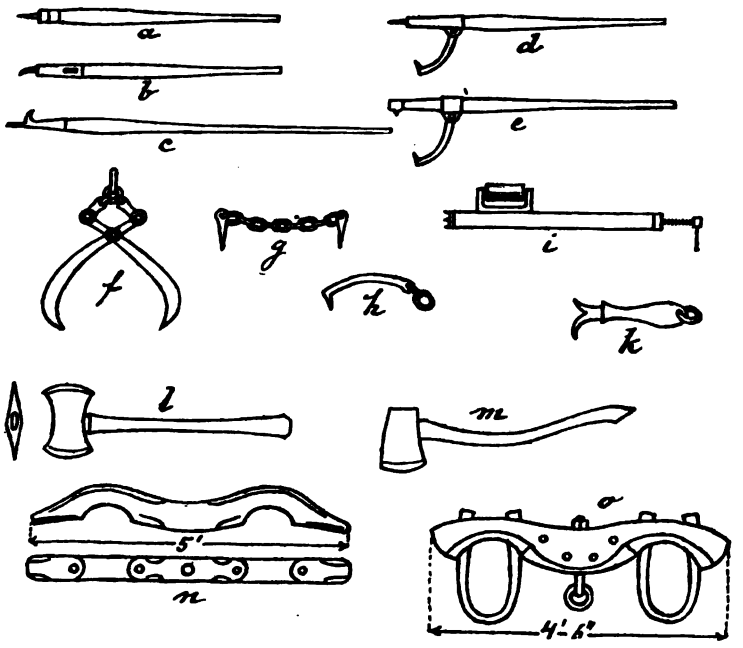


FIG. 23.—Lumbering tools.

the surface. This hot water might be taken from a spiral flue inside the offal furnace or from the boiler. By these means the thawing of the logs is kept up, and when the doors open a sufficient quantity of warm water leaks out to keep the open space in the ice free from freezing. In order to protect this water from losing its warmth to the surrounding water a wooden partition is built (fig. 22). resting on the edge of the ice, about 4 feet in depth, 3 feet being below the water. Thus the water inside this partition generally has a temperature on the surface of about 10 to 20° above freezing point.

Log-thawing boxes of this construction have been built by the Yawkey & Lee Lumber Company, and at Hazelhurst, Oneida County, Wis., etc., where they seem to have given satisfactory results.

Lumbering tools of superior quality, both as regards shape and material, were exhibited by Morley Brothers. A few of these tools are shown in figure 23, *a* to *k*, two different kinds of ox yokes with bows being shown in *n* and *o*.

Tools for the same purpose were also exhibited by the Oshkosh Logging Tool Company, Oshkosh, Wis. Among these tools may be specially mentioned:

(a) Peaveys of different kinds (*d*, *e*): split-socket peavey, solid steel socket peavey, ring and clasp peavey, and socket and clasp peavey. Their handles, as well as those of the other tools, are generally made of ash or maple, and the sockets have a tapering shoulder under the hook, which gives a surer catch. As regards the heads of the hooks four styles are made, viz, duck bill, round bill, diamond bill, and chisel bill.

(b) Hand spikes (*a*), used on rollways and on drives as a pinch bar in breaking a jam. The picks are made of square steel and driven into the wood.

(c) Pike poles (*b*), from 12 to 20 feet in length, and in three different styles: Straight pike only, straight pike with hook, and curved pike with hook, all screwed in.

(d) Pickaroons (*c*), either with hook only or with pike and hook.

(e) Skidding tongs (*f*), with flat, octagon, or square section.

(f) Rafting dogs, made in four styles, viz, chain dogs (*g*), ring dogs, eye dogs, and pin dogs.

Further may be mentioned logging dogs, chain hooks, swamp hooks, rollway breaking and loading hooks, and cold shutes. Lumber rollers for loading and unloading cars are shown in *i*. The ox yokes, shown in *o*, are made by Morley Brothers, and are manufactured of maple wood, strongly ironed, and have such proportions as to rest easily upon the animals' necks and secure good results as to draft. The bows are made of second-growth shelibark hickory, in such a manner as to retain the bark in the bend of the bow. They are semicircular in section at the bend and circular at the ends (diameter 1¾ to 2¼ inches). A somewhat different style is shown in *n*; this was exhibited in the New South Wales (Australia) exhibit and was made of Murrumbridge oak.

Among the most interesting exhibits in connection with the forestry department was the sawmill. This was placed in a special building near the machinery hall, and attracted the greatest attention from experts as well as from the general public. Two sawmill plants were installed for practical operation, one by Stearns Manufacturing Company, of Erie, Pa., and the other by E. P. Allis Company, of Milwaukee, Wis. Both these mills were indeed first-class and it would be a rather difficult task to decide, or judge, which was the better.

It is a well-known fact that the introduction of band saws for cut-

ting logs has met with great difficulties, and especially in Europe there are still at this time not many band sawmills to be seen, though several firms, so well known as Arbey & Co., Perin, Panhard & Co., Ransome & Co., and others, have tried to gain the market for them. Still there may be special reasons why this tool has not gained the confidence of the sawmill owners in Europe. If we think of the northern countries of Europe, such as Sweden, Norway, or Russia, the timber grown and cut in these countries consists mostly of softer kinds of wood, such as pine and spruce, which has a straight, even growth and very seldom attains any larger dimensions. The band sawmill seems to be of greatest use in those cases when the timber has such growth or size that the cuts ought to be different in the same log and different in one log from another, in order to convert it to the most practical size and "grainage." For this reason it will be clear that, though the band sawmill will probably gain a larger ground in the above-mentioned countries than it has at present, it will never supersede the ordinary gang

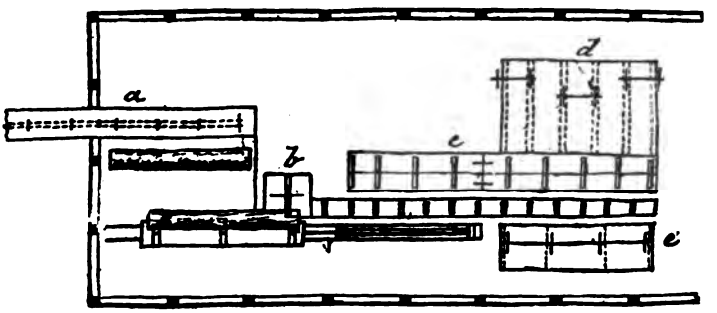


FIG. 24—Plan of band-saw mill.

or, as it is generally called in Europe, frame sawmill. In consequence of failing experience in the use and construction of this type of sawmill the European manufacturers have not been able to supply them in such condition that they produce satisfactory results. It will then be evident that the working of and practical result from these modern machines was watched by the foreigners with more than common interest.

Figure 24 shows a general plan of a band-saw mill, as arranged at the exhibition. The logs are hauled up on the inclined plane *a*, then rolled down the carriage for the band-saw *b*, the boards (blanks, deals, etc.) being afterwards edged at the bench *c*, and lastly trimmed or cross cut by the machine *d*, while the refuse from the edger is trimmed in another machine, *e*, for staves, laths, pickets, etc.

A band-saw machine, as constructed by The E. P. Allis Company, is shown in figure 25. The wheels are 8 feet diameter, and carry saws 12 inches wide and 45 feet in length. The saw generally in use had a thickness of three-sixteenths of an inch, had swaged teeth (fig. 26), with

a distance of 1¾ inches between joints. It could make a cut 44 inches deep, the machine having a distance of 54 inches between column and saw for lumber to fall down. This firm makes three sizes of band-saw mills, the other two having wheels 9 feet in diameter and carrying saws 54 and 50 feet, respectively, making cuts 72 and 48 inches, respectively. The inside of rim of lower wheel raises from the edge to the center on an angle of approximately 45°. This raise in rim prevents sawdust staying thereon. The bed of the machine rests on the floor timbers in the same manner as a circular mill. The top

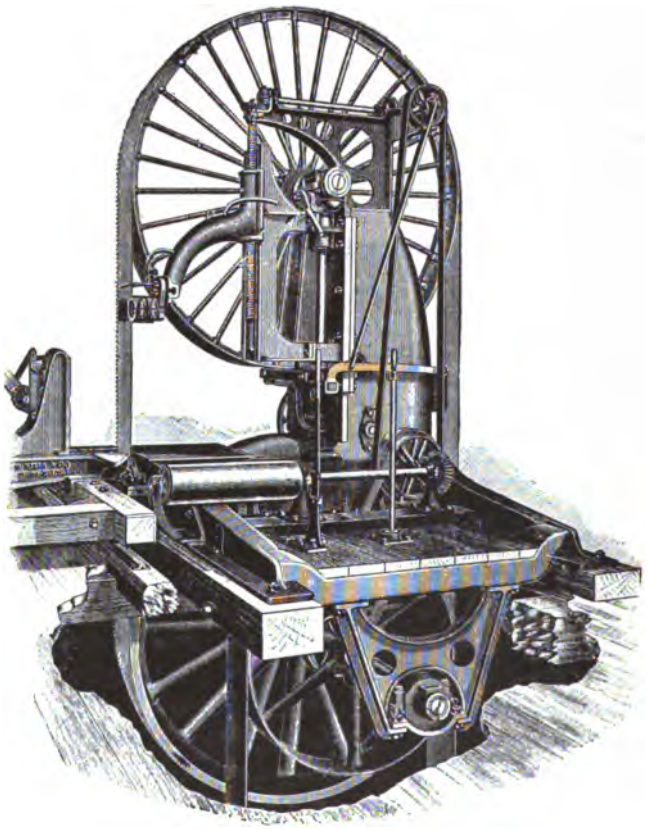


FIG. 25.—Band-saw mill.

guide arm is raised and lowered by power taken from the lower arbor. Immediately behind the saw is a roller for carrying away cut boards, driven from the lower arbor, which is provided with ball and socket boxes, whereas the upper arbor is provided with universal, adjustable boxes, the stems of which work in open cylinders and project at lower end to receive tension rods. By a special arrangement, water is applied to each side of the saw immediately above the top guide. This mill can be arranged for sawyer to stand in front or rear as preferred (the wood cut represents feed lever in rear).

The logs must be held on the skids or "log deck" when not wanted. An arrangement for this purpose, which was in use at this mill, is shown in figure 27. This log roller gives no possible chance of the logs rolling down and endangering the carriage until one is wanted for use, when one can instantly be placed on the carriage when wanted. This "Kline steam log roller" consists of two or more curved arms A, keyed to a shaft, placed in the skids parallel to the carriage track with concave side of arms upward, into which the log rolls as into a cradle. These arms are caused to rotate by means of a steam cylinder B, connected to one of the arms by connecting rod E, and operated by the foot pedal L.

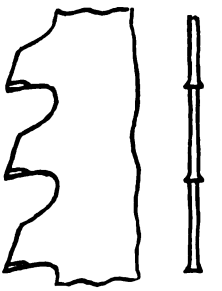


FIG. 26.—(See page 579.)

A very ingenious arrangement for quickly handling logs and turning them round for fresh cuts consists of the "steam nigger," shown in figure 28. By the use of this handy tool the effectiveness of the modern sawmill has been greatly increased. Its working part is a strong iron beam or rod with projecting dogs to catch the wood during motion upward, whereby the log is turned round; these dogs are pressed against the rod during downward stroke, thus not affecting the log. This rod has at its lower end two projecting arms, to which are connected two piston rods moved by steam. By means of a steam valve operated by the lever, shown on the right side in figure 25, steam can be made to enter one or both the steam cylinders, thus causing the "nigger" to move to or from the log, or it can be moved up and down as desired. It requires much practice to handle this lever properly, as may easily be imagined, in order to give exactly the right amount of power to the pistons and thus obtain the proper motion and effect.

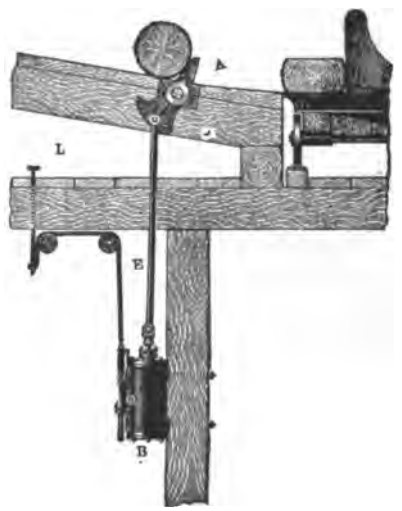


FIG. 27.—Log roller.

Steam is also used for feeding the log against the saw. A direct-acting steam feed is shown in figure 29. The carriage is running on rails, one of which (nearest the saw) is flat on the top (fig. 36), the other V-shaped (fig. 35). At the back end of this carriage is fixed a piston rod, moving in a steam cylinder of the same length as the carriage. By letting in steam on one or the other side of the piston, the

carriage can be moved backward and forward, the speed depending upon the amount of steam passing the valve. The whole length of track is 30 feet, the length of log varying from 15 to 20 feet. In the machines exhibited the rate of feed amounted to about 3 feet per second, the back motion having about double speed. Thus it would take about five seconds to cut through the log, seven and one-half seconds for back motion in addition, and 8 cuts could be taken per minute, which speed, under favorable circumstances, could be increased to 12 cuts. During the back motion the timber is passing at a little distance from the saw blade, about one-half inch being allowed for clearance.

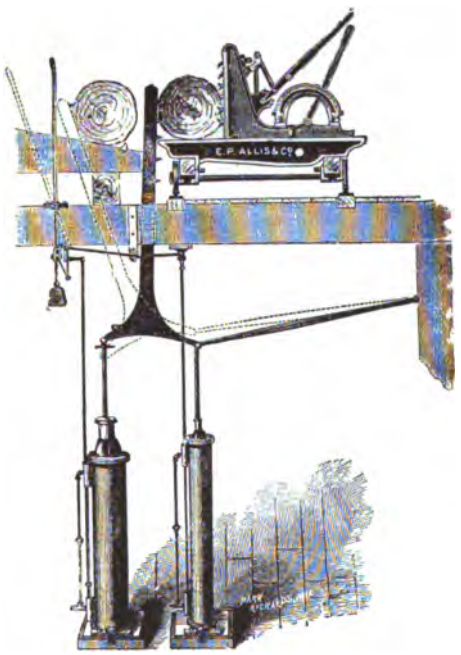


FIG. 28.—Double-cylinder steam nigger.

In order to hold the log during work and shift it after each cut, there are several mechanical arrangements necessary. On the top of the wooden frame of the carriage are fixed two or more head blocks, on the top of which the knees with the dogs for holding the log are sliding. The knees have a taper or independent movement, and by this device each can be set back or forward of line independently of the others, to accommodate taper logs and to straighten long timber. Besides this independent motion, all the knees can be moved together by means of a "fractional set" arrangement controlled by a single lever, so that the log can be set rapidly to one-sixteenth of an inch under all conditions. This is accomplished by the use of double-action pawls, which catch each notch of the ratchet, thus insuring a perfectly rigid position of the log during work.

Of special importance in the construction of the different parts of the carriage is the precision and uniformity in the setting, so that the lumber has a uniform and exact thickness; also the ease with which the operator or "setter" can vary one thickness to another without any calculation or figuring on his part. The end has been gained by the very perfect arrangements shown in connection with these band sawmills.

A brake wheel or buffer on set shaft is used to ease the knees in receding and to take the shock of logs which are being turned or rolled

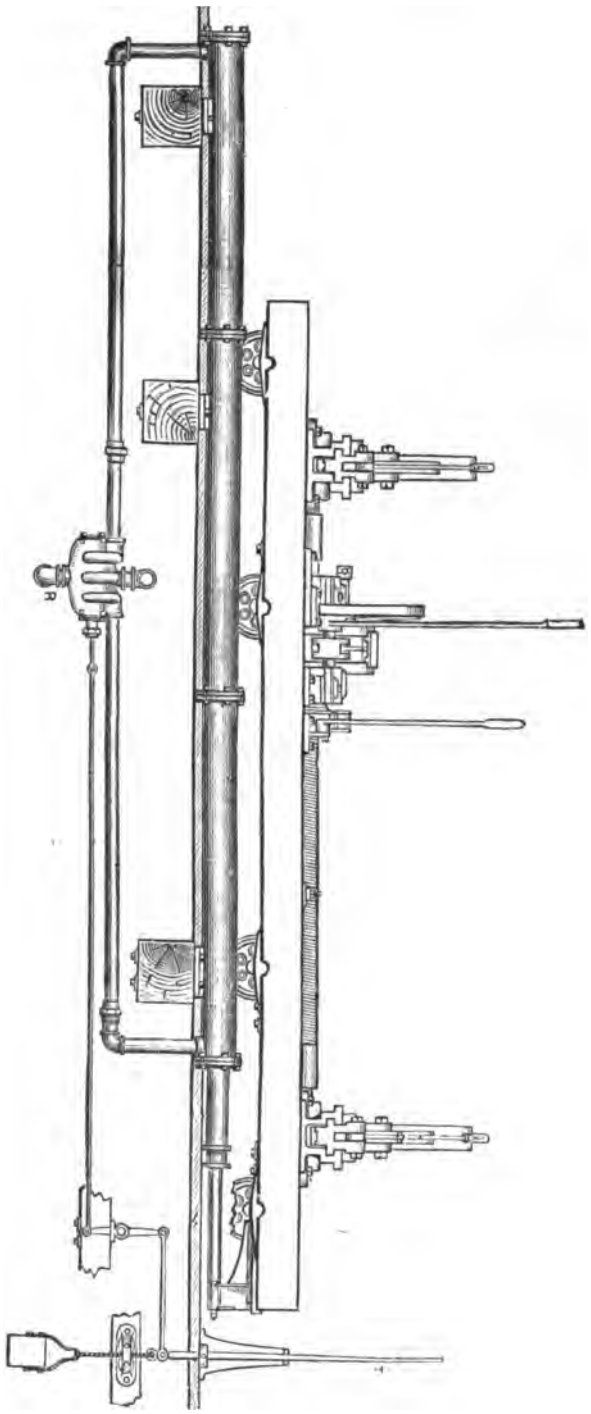


FIG. 29.—Direct-acting steam feed.

against the knees. By this means all the working parts are saved from possible fracture. The knees recede either by a friction or a spring device.

An index wheel and graduated scale is geared to the set shaft, and as the knee moves toward the saw the index wheel turns toward the setter, showing the exact distance of the knee from the saw.

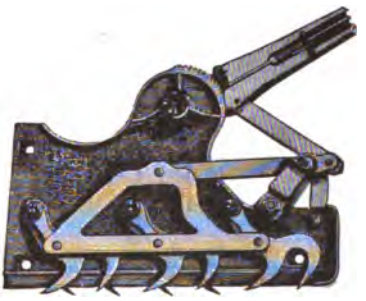


FIG. 30.—Double-tooth dog.

For holding the log during work there are used dogs of different construction. Figure 30 shows the "Reliance" double-tooth dog. It has double-grip hook teeth, working in both directions, up and down, all operated by one lever. The teeth advance 2½ inches to hold the round log, and five-eighths of an inch to hold the last board.

Figure 31 shows an extension cant-hook dog holding log in position. The length of the cant hook may be extended or contracted to adjust it to various sizes of logs. The double-speed dog, running in close-fitting ways, effectually prevents the log from changing position.

A dog intended for quarter sawing is represented in figure 32. As explained hereafter, there is always more or less wasting of the wood in quarter sawing, this depending partly upon the circumstance that

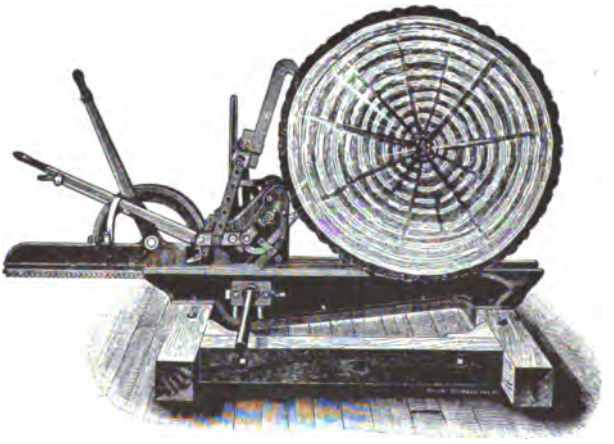


FIG. 31.—Extension cant-hook dog.

the last piece of the quarter can not be cut, as the dogs must grip this part during work. By the use of the dog shown in figure 32 this part is reduced to a minimum. The dog can be fixed to an ordinary knee, and has two jaws with straight teeth, moved by means of a lever.

Figures 33 and 34 are two other constructions of quarter-sawing

dogs, the former being Atkins's under dog. Among other things may be noted Knight's Excelsior dog and Craney's single-tooth dog.

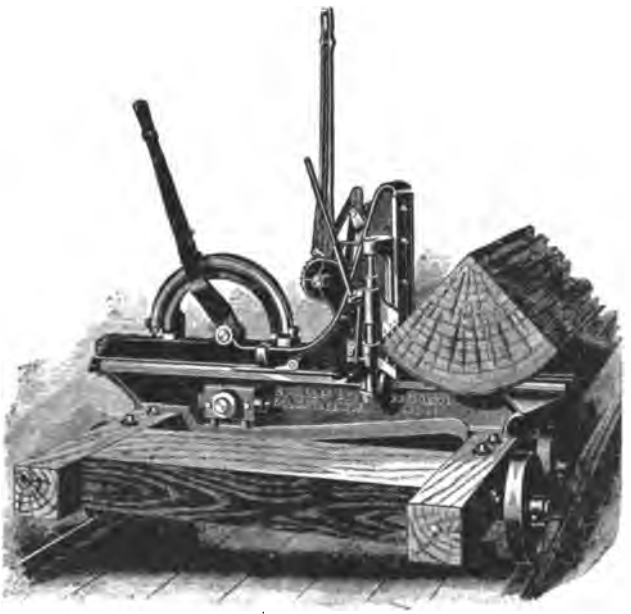


FIG. 32.—Quarter-sawing dog.

A special feature in the construction of all these arrangements on the carriages is that, in case of breakage, any part may be easily changed and substituted for another, being mostly of cast iron or steel, and made to exact gauge at the factories.

The track upon which the carriage runs is rolled in lengths of 10, 12, 14, 16, or 18 feet. The cross sections are shown in figures 35 and 36.

FIG. 33.

Before leaving the subject of band saws there might be said a few words as regards their straining and speed of tooth. According to observations, made at the place, the wheels were running at a speed of 208 revolutions per minute when the machine was at work. This would give 5,220 feet per minute (with a diameter of 8 feet), which would agree with the speed ordinarily given to band saws. If the speed is increased too much the saw blade will vibrate and difficulties arise in getting an even cut and good surface.

It was said by the gentlemen in charge of these mills that the rate of feed ought to be 2 feet for each total revolution of the saw. The above-mentioned saw makes 116 total revolutions per minute (being 45 feet long). This would make 232 feet per minute, or nearly 4 feet per second, which feed would be somewhat quicker than the one generally used (3 feet per second).

The question of the amount of strain on a band saw is of great

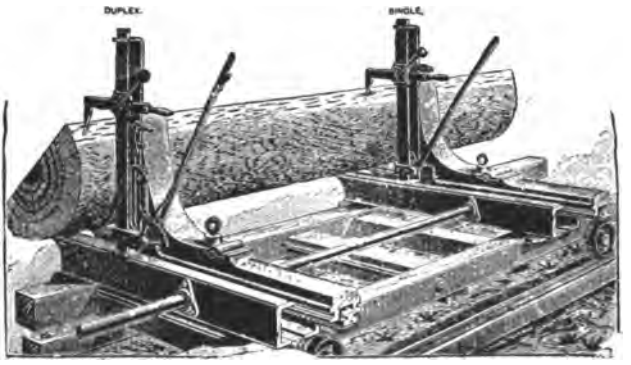


FIG. 34.

importance. On the one hand a certain tension is necessary to keep the saw blade in a straight cut; on the other too great tension would soon produce a breakage. And another circumstance which would influence the durability of the saw blade is the diameter of the wheels. At a glance on figure 37 it will be seen that the saw blade, when traveling over the wheel, is stretched on the outside half part of its thickness and contracted on the inside half part. The greatest

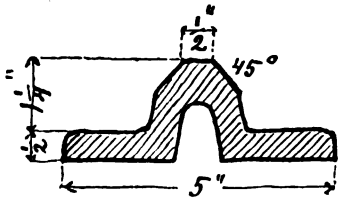


FIG. 35.

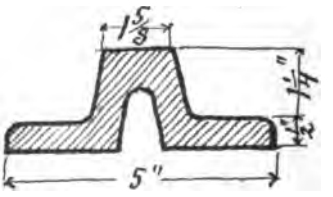


FIG. 36.

lengthening L on the outer surface is

$$L=(D+2s)\frac{\pi}{2}-(D+s)\frac{\pi}{2}=s.\frac{\pi}{2};$$

The lengthening of unit of length is consequently

$$\frac{s\pi}{2} : (D+s)\frac{\pi}{2}, \text{ or } \frac{s}{D+s}, \text{ or nearly } \frac{s}{D};$$

But, if E signifies the modulus of elasticity, S the specific force

(pounds per square inch), which will cause a lengthening $\frac{s}{D}$ of the original length, then, according to the theory for elasticity,

$$E = \frac{S}{\left(\frac{s}{D}\right)}, \text{ or } S = E.\frac{s}{D};$$

In the above-mentioned band saw is D = 8 feet and $s = \frac{3}{16}''$; consequently (E = 35,500,000 for hardened and tempered cast steel):

$$\frac{s}{D} = \frac{1}{512}; \quad S = \frac{35,500,000}{512} = 70,000 \text{ pounds per square inch.}$$

To this must be added the strain on the saw for keeping itself straight during work, which ought to be about 5,000 pounds per square inch. This total strain, 75,000 pounds, must necessarily fall a great deal below the elasticity of steel, which can vary between 110,000 and 150,000, but in certain cases might go down to 80,000 pounds per square inch, depending upon the quality of the steel, the mode of manufacturing the saw, together with hardening and tempering. It would, indeed, be interesting to hear of some trials in this direction with American band-saw steel, and at the same time some experience about how long a band-saw blade will last for a certain strain and during daily work. There is a great lack of experience in this subject in all the countries of Europe.

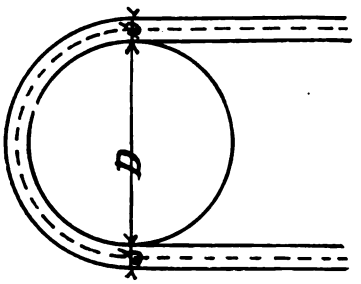


FIG. 37.

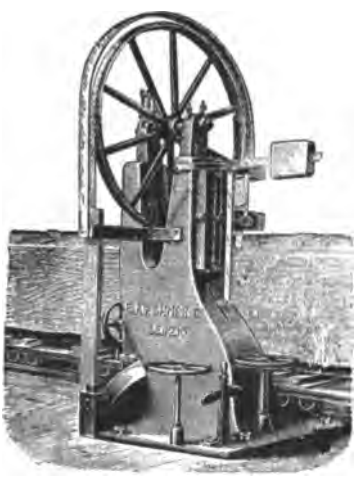


FIG 38.—Band sawmill.

Figure 38 represents a German band sawmill, showing a different construction to those before mentioned. It was exhibited by E. Kirchner & Co., Leipzig, Germany. The wheels were 8 feet 3 inches in diameter; the upper with double system of arms, the lower with a solid disk, acting as a balance wheel. The tension on the saw blade was obtained by means of weight and levers. The motion of the carriage was effected by rack in the ordinary way. As this mill was not

in operation it was, of course, difficult to judge of its practicability, but it seems to have been introduced into many sawmills on the European continent. The saw blade was very thin, only three-thirty-seconds of an inch, 8 inches wide, the teeth being one-half inch in height, 2 inches apart, and not swaged but set.

Quarter sawing or rift sawing is generally more used in America than in Europe. This mode of converting the lumber has several advantages which are not fully taken into consideration in European practice, partly owing to the fact that gang mills are mostly in use, and consequently this manner of cutting is impracticable. Another reason is that in the Northern lumber-producing countries of Europe, such as Russia, Sweden, Norway, etc., the most common kinds of wood are pine and spruce, which have no visible medullary rays, and consequently but little is gained in the appearance of the grain by being thus cut. Perfect rift sawing is showing in figure 41, No. 13. So-called "bastard sawing," or what might be called false rift sawing, is shown in all the other numbers, where cuts are made parallel with the main cuts which go through the center. The name "quarter sawing" arises from the common method of first cutting the log into quarters and then cutting the quarters in one or other way, as indicated in figure 7. Such quarter sawing is of great use when the wood has to withstand continuous wear, as in the case of flooring, the medullary rays being of a harder substance than the other parts of the wood; or when it is essential that it must neither shrink nor warp, as in the case of sounding boards for musical instruments. Wood thus manufactured can be submitted to drying without becoming twisted or warped, which is not the case with ordinary rip-sawed wood. This latter will also, if laid in a floor, wear rapidly and unevenly, whereas quarter-sawed wood will wear evenly and present a better appearance. Another advantage is the beautiful effect produced by the grain, as the medullary rays generally have a different color, and, being harder, receive a higher polish than the surrounding material. The value of the lumber is thus greatly increased, as well as its usefulness for inside finish, furniture, flooring, etc., where durability and artistic effect are desired. Sycamore, for instance, is always cut in this way, and oak, maple, poplar, and elm, or hard woods, will generally be greatly improved. Especially worth noticing at the forestry exhibition were the beautiful specimens of quarter-sawed oak, both in large boards and in manufactured articles, such as panels and doors. The oak-furniture industry is of great proportions in Europe (Sweden produces such furniture even for export), but this manner of showing the grain to its best advantage is too much overlooked. There will, of course, be a certain amount of waste wood, from 3 to 6 per cent, as the cut pieces have a bevel edge, which must be squared by the edger.

The kind of timber and the purpose for which the product is intended must in each case determine how the log is to be quartered. Several

ways are shown in figure 41, which will be understood without further explanation. Nos. 1 to 6 show a truer quarter sawing than the others, with 4 different positions of the log for cutting each half part. No. 7

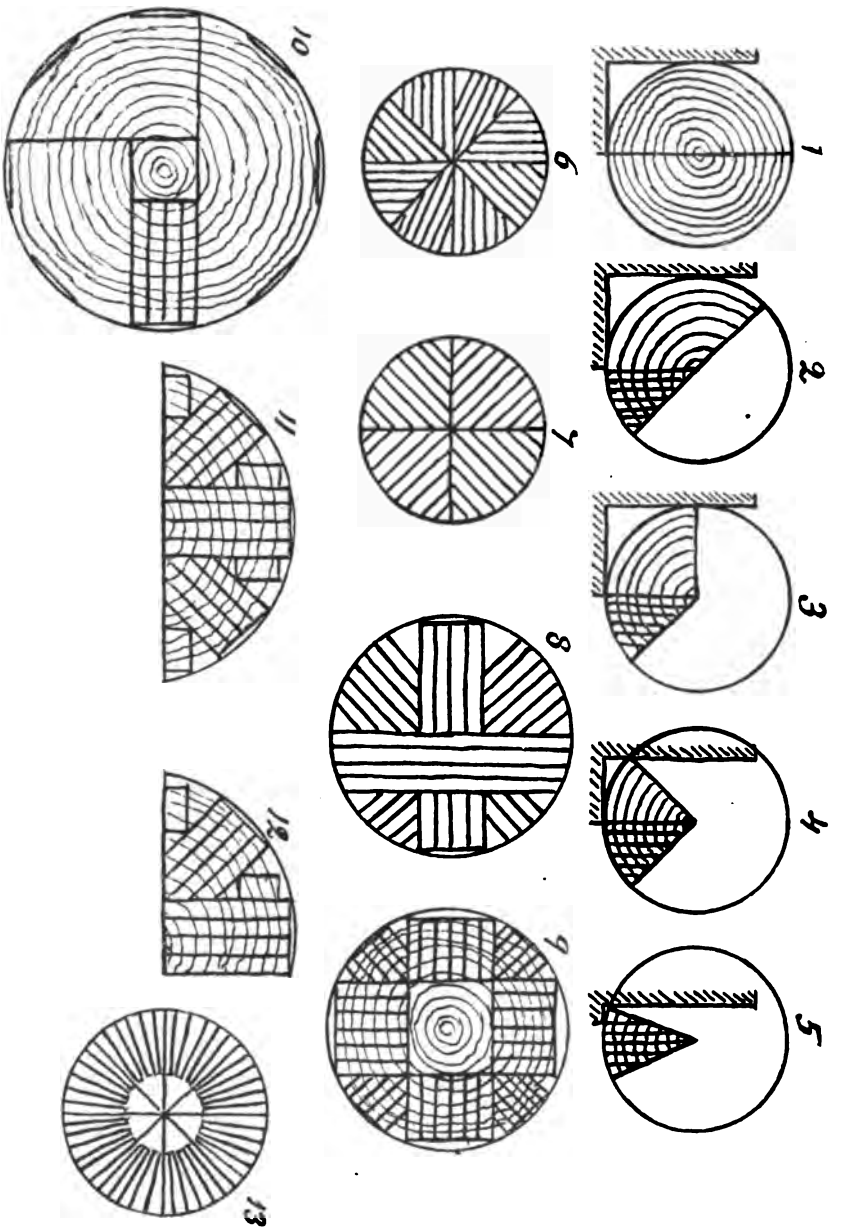


Fig. 41.—Quarter sawing.

shows another method; in 8 and 9 the log is cut in such a way as not to produce so much waste, which is also the case with 10 to 12.

Very few gang-saw mills were exhibited, among which one manu-

factured by E. Kirchner & Co., Germany. This mill or "frame saw," as they are named in Europe, was of the ordinary vertical, roller-feed type. A characteristic feature consisted in the standard being constructed of wrought-iron bars of double T-section, the same being the case with the swing frame, fitted with guide blocks of oak and connecting rod pins fixed on the middle of the side bars. The feed was intermittent and effected by means of friction wheels with pawls, the motion being transmitted to all the 4 feed rollers by an "endless" chain. The carriages were of the usual construction, with dogs movable by a screw.

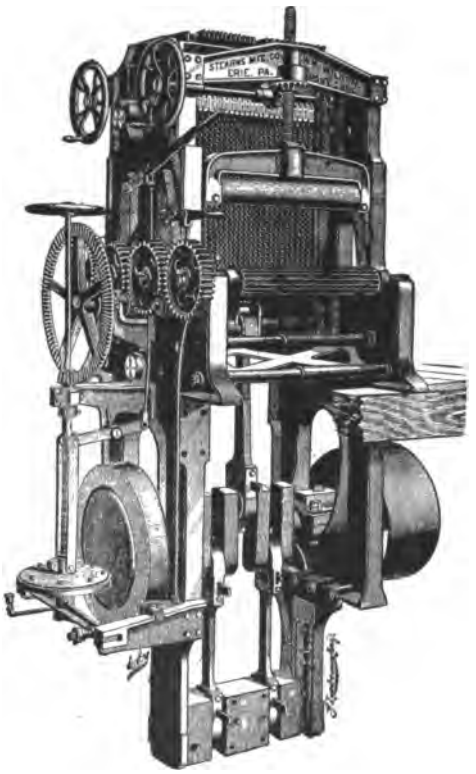


FIG. 39.—Compensated gang saw.

A very interesting construction of a gang saw is shown in figure 39. This machine is built by Stearns Manufacturing Company, and was not exhibited, but is well worth attention among sawmill experts as being a trial to balance or compensate the swing frame. The crankshaft of this "pony gang frame" has a double throw, one crank for the swing frame and two cranks at 180° for the balance weight, which is thus moved by two connecting rods, one on each side of the rod for the swing frame. This manner of compensating the swing frame is more expensive, there being two extra connecting rods necessary besides the bottom crosshead with its guides, etc. But it has certainly the advantage of being founded upon right principles, which is more than can be said about the general way of balancing by counterweights on crank or fly wheel. If the saw is at rest, there is such an equilibrium in the latter case; but when the saw is working, the conditions are entirely different, as will be seen by the diagram in figure 42. When the crank pin is in its upper position the centrifugal force of the swing frame and connecting rod is acting upward with the same power as the balance weight is exerting downward. In the lowest position of the pin the reverse will be the case. But in a horizontal position of the crank only a small part of this centrifugal force is

active on the crank pin (namely, the weight of the pin and of the connecting rod head), whereas at the same time the balance weight is working with its full force on the opposite side. In an ordinary frame, making 200 revolutions per minute, having a radius of 16 inches, a connecting rod weight of 100 pounds, and a weight of swing frame with saws of 550 pounds, causes a horizontal strain of not less than 11,500 pounds. To compensate this additional strain, which acts successively to the right and left, it is necessary to fix the frame on a very heavy foundation, and it would certainly work better without any such rotating balance weight. Entirely different is the case with the above-mentioned "pony gang," which will be almost entirely balanced, with the exception of a bending instant on the crank shaft, when the crank passes the vertical position.

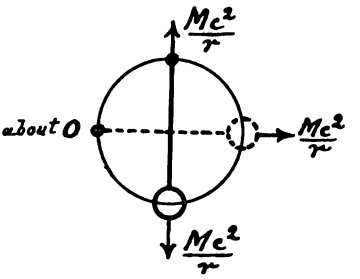


FIG. 42.

A kind of sawmill which hardly would be found in Europe is the muley sawmill, shown in figure 40, as manufactured by Chandler & Taylor Company, Indianapolis. The saw blade is guided by means of two rods, having no straining, as there is no swing frame. The crank shaft makes about 500 revolutions per minute. The saw has a vertical motion on its downward stroke and recedes on the upward stroke, giving clearance to the teeth. The feed is continuous. The special advantage of this mill is the small amount of power necessary for driving. A circular sawmill was exhibited by A. B. Farquhar, Pennsylvania. It had the ordinary rack feed motion for the carriage, fitted with self-receding head blocks in gigging. An improvement consisted in a friction arrangement for the feed, whereby different speeds were attainable. This was effected by shifting a friction wheel, revolving against another.

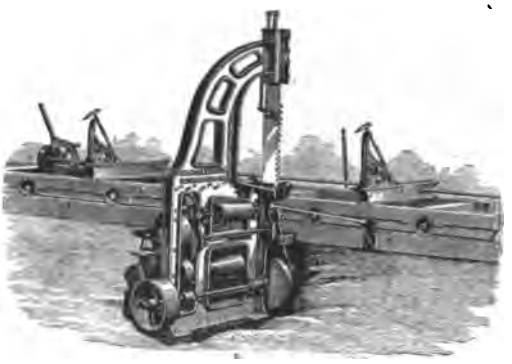


FIG. 40.—Muley sawmill.

Edging benches.—After the log has been cut into certain thicknesses in the band, circular, or gang saw (deals, planks, scantlings, floorings, ceilings, etc.), the wood has to be edged, which is generally done in circular saw benches. This process is of great economical importance,

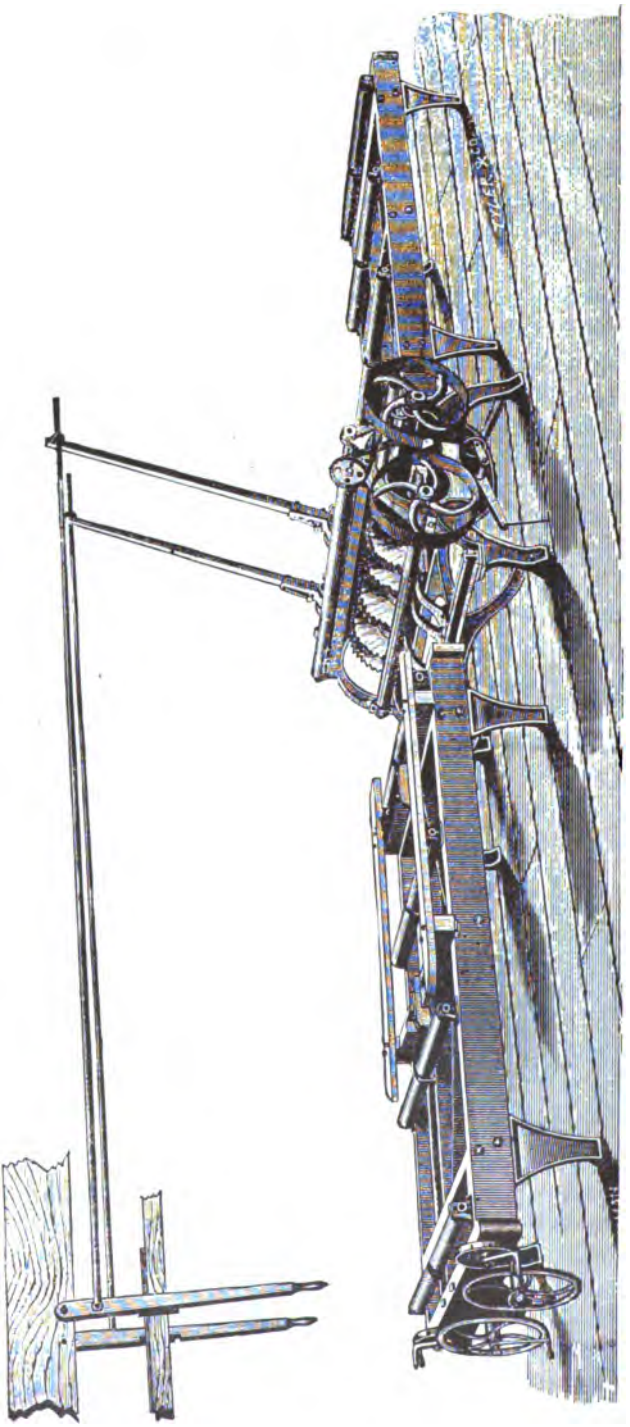


Fig. 43.—Double 5 saw gang edger.

and a judicious man is required to operate the edging machine, as much waste then might be converted into profit, while with a bad edger the savings of all the other part of the mill may be converted into loss. Especially is this the case with pine, in which classification and price is more distinct. By skillful sawing the largest piece of the higher grade might be cut from the board, and at the same time a merchantable strip of lower grade be received, whereas if cut in another way the board might be edged to its full width, but go into the market as inferior.

The American edging benches differ in several respects from those used in Europe. They are generally provided with several saws, and are so arranged that the operator stands at the end of the table, in front of the machine, thus easily overlooking the whole length of the board. Figure 43 shows a "double five saw gang edger," exhibited by Allis Company. In this machine the two outside saws are stationary and set 6 inches inside of side guides, so that when the guides are way out a 6-inch strip is made on either side the table. The three inside saws are independent and can be moved to any position on the arbor. The bearing on one end of the arbor end is removable, being placed on a so-called "slip bridgetree," so as to enable easy changing of the saws. The movable saws are handled by the guides having wooden pins coming in contact near the front or cutting edge of the saw plate. The distance between the saws is adjusted by means of handwheels in front of the table. The bottom feed rollers are grooved and have independent motion; the top rollers can be raised and lowered by hand levers, thus controlling the feed. The tables are double, so that boards of different thicknesses might pass through at the same time. There is a return roller on the top for unfinished lumber.

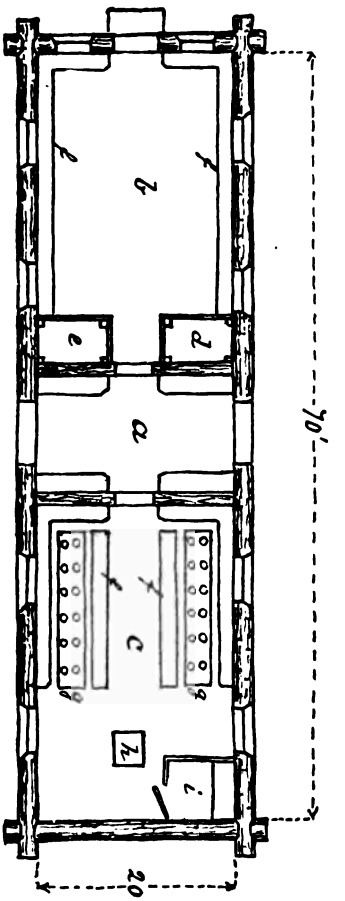


FIG. 44.—Michigan logging camp.

a, passage; *b*, sleeping room; *c*, eating room; *d*, sleeping berth; *e*, wooden partition; *f*, seats; *g*, tables; *h*, hearth; *i*, kitchen.

The next process is the crosscutting of the ends, which is done in a "trimmer," a purely American tool. This machine consists, gener-

ally, of a table, on which the board is fed against the crosscutting saws by chains. The number of the saws varies from two to six or seven, depending upon the length of the boards. The two outside saws are fixed; the inside saws run below the table, each being connected with a foot treadle, which enables them to be raised into position for cutting. There is about 10 or 12 feet distance between the outside saw and the next one, and 2 feet between the others. By thus placing the board on the chains and by pressing the foot on either of the treadles the board may be cut to its greatest length on both ends simultaneously.

Before leaving the subject of lumbering it would only be an act of justice to mention the extremely interesting exhibit, well known, especially to foreign visitors, under the name of "Michigan logging camp." This building, placed north of the sawmill and erected by the State of Michigan, was intended to give an idea of a lumberman's life in the forest, and in this sense it was certainly a success, being a little link for itself in the long history of culture.

The camp was built of rough logs, saddled together at the ends, making a building about 70 feet in length, 20 feet in width, and 8 feet in height on the sides, having a plain roof of unbarked, rounded hemlock shingles, laid together in two layers, in the manner of curved brick tiles. The building was divided in two rooms, with a passage between (fig. 44), one room being intended for sleeping and general sitting room, the other for eating room and kitchen. On the walls, both inside and outside, were placed a lumberman's necessary tools, axes, handsaws of all kinds, pit saws, spikes, and hooks, etc., lumberman's boots with pointed steel nails on the bottom not to be forgotten. Around the walls were the sleeping berths placed in two rows, one above the other. An ordinary camp accommodates about twenty-five men, but exceptionally up to sixty or seventy might live in it. The time of occupation is five to six months (September to April). There is either an open hearth on the floor for heating purposes, the smoke escaping through a hole in the roof, or an iron stove is used.

III. Worked Timber and Lumber.

There has been a general complaint that manufactured articles of wood, coming under the name of forestry products, were too scarce at the exhibition. While forest resources or raw materials were represented in great profusion and endless variety, giving a fair view of the natural products of different countries and states, comparatively few exhibits were shown representing the use of the wood in the arts in the shape of articles finished for use. A few exhibits made a splendid exception to this general rule, notably Michigan, New South Wales, Japan, and Russia.

Shingles, manufactured both by splitting and sawing, were extensively exhibited, being made from different kinds of wood and of dif-

ferent shapes and dimensions. A complete set of shingle-making machinery was exhibited by Novelty Iron Works, Dubuque, Iowa. The lumber is cut into certain lengths in a drag cut-off saw, then made into bolts, which are cut into slices in the shingle machine, consisting of horizontally placed circular saws of very thin guage and fixed to disks. Afterwards the shingles are edged and made into bundles in special packing machines. In a machine with two saws 150–250,000 shingles can be manufactured in a day.

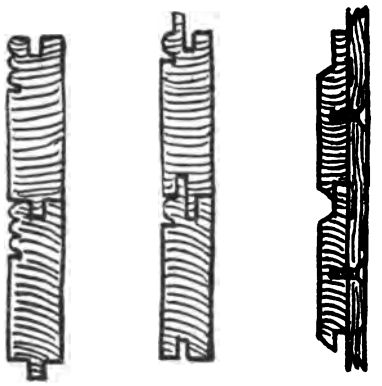
Splendid specimens of shingles were exhibited by New South Wales. They were split from the forest oak (*Casuarina torulosa*), which tree resembles a pine tree, having needle leaves; these shingles had a length of 14 inches, being 6 inches wide and $\frac{5}{8}$ inch thick, overlap 4 inches. Michigan exhibited shingles of pine and cedar, also from yellow poplar. The best sawed shingles are made from split, quartered white pine. The dimensions of North American shingles vary between 14, 16, 18 (most common) inches up to 24 inches in length, 4 to 6 inches in width, five-eighths in the butt end and one-eighth at the point. Shingles made from yellow poplar were exhibited by Gieseke Shingle Company, Livermore, Ky. Dimensions 16 by 5 by $\frac{5}{8}$ by $\frac{1}{8}$ inches. One of the finest exhibits in this way was made by Edwin S. Hartwell, Chicago, who displayed different manufactured wooden articles, worked into the construction of a complete building, 12 by 14 feet in size. The lower portion of the walls was formed of three tiers of pine logs, the sides were covered with 4-inch bevel sidings, and 4 turned columns, extended above the roof, formed the corners. The roof was covered with a special shingle, 20, 24, and 26 inches long, 6 inches wide, and five-eighths inch at the butt end. The interior of the building was finished entirely with "dimension shingles," showing a good outside finish without being planed (by the use of special planing saws) and representing not less than eleven fancy patterns. The names of these patterns are: Diamond, square, hexagon, octagon, segment, round, gothic, single and double concave, scallop and fancy scallop. They are made 16 or 18 inches long and 4, 5, or 6 inches wide.

A great variety of useful wooden articles were exhibited by Richardi & Bechtold, Michigan. Among these may be mentioned household-furnishing woodenware, all of excellent workmanship and good materials, such as chopping trays of hard maple, vinegar measures (with solid handles, and saturated with a preparation, being afterwards finished in oil), butter molds, ladles and spades, scoops (turned and bored), etc. Further, dairy utensils, bakers' and confectioners' utensils, spice cabinets of ash, napkin rings and paper knives of bird's-eye maple, bread plates artistically carved, and all kinds of ash handles. This is an especially neat industry, well worthy of attention, as thereby a great amount of hard-wood refuse is utilized.

The National Ladder Company made an exhibit of a rather novel

kind of ladder (Ayer's patent), being made in sections of 7 feet in length. These sections are somewhat narrower at the top, so that an upper section might fit outside a lower one, the ends being pushed together until the steps are resting in slots made at the ends of each section.

Some beautiful specimens of hard-wood articles were shown in the exhibit of New South Wales, namely, gunstocks of darkly colored wood, finely polished. The wood for this purpose was black bean, sycamore, honeysuckle, hickory, forest oak, red bean, lightwood, and myall. Another article at the same place consisted of paving blocks made from blackbutt (*Eucalyptus pilularis*), which is a straight-grained, hard, and heavy wood, especially suited for this purpose. A bullock yoke made of Murrum bridge oak is shown in figure 23 n.



Russia exhibited shaft bows of willow, bent in U-shape and with carved ornaments, balusters of elm and lime tree, bakers' troughs of poplar, household vessels of oak, birch, poplar, etc., flower stands and folding chairs

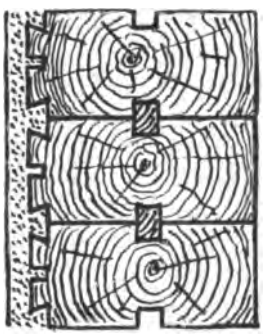


FIG. 45.

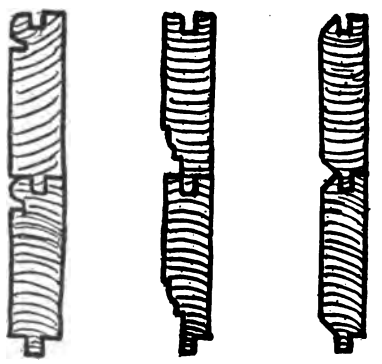


FIG. 46.

of lime tree. The government of British India displayed a beautifully carved mantelpiece, flowerpot stand in carved blackwood from Bombay, door and panels of padoak wood grown in the Andaman Islands, etc., all tropical hard woods, some of them emitting strong scents from resinous matters. Michigan exhibited a special article, "excelsior," or "wood wool," consisting of thin shavings, suitable for packing and similar purposes, and made in different degrees of coarseness. Another rather singularly manufactured article consisted of

sidings or weatherboarding for houses, being produced by radially cutting a round block by means of a circular saw in the manner indicated by figure 41, No. 13. These strips had a width of 6½ inches and a thickness of about three-fourths and one-fourth inch, respectively, at the thick and thin edges. The advantage of this mode of cutting is evident. There is no wasting of the wood (the core being used for some other purpose) and the boards will better resist warping and shrinking, being truly quarter sawn.

A peculiar way of erecting wooden buildings was illustrated by the Cyclone building lumber (J. S. Goodvin's patent). Figure 45 indicates this manner. The dimensions of the timber were 6 by 2½ inches, an inside coating of lime or clay being affixed by means of the dovetails.

Among different modes of matching boards together for wainscot, panels, sidings, etc., exhibited by West Virginia (Parkersburg), Michigan, and Canada, a few specimens are shown in figure 46.

V. Minor Industries.

1. WOOD PULP.

Among those industries which during later years have grown up in connection with a more rational utilization of forest products, hardly any one has shown such a powerful and large development as the manufacturing of wood pulp and its use for different industrial purposes. It is only necessary to glance at the exhibited articles in this branch in order to understand that the utilization of this material still is in a period of development which promises grand results in the future. The wood pulp was originally produced to serve as a substitute for rag in paper making, in which trade it still plays its most predominant part. By and by it has taken the place of raw material for many different articles, such as household utensils of all kinds, vessels for transport, pipes, doors, furnitures, floor tiles, carriages, ornaments, etc., not to mention boats and houses. By means of the different methods for the hardening of the pulp invented during later years, new fields of enterprise have been opened for its use.

It has been said, not without reason, that the wood-pulp industry, in spite of its useful results, is of great detriment to the country, as it causes the more youthful and strong part of the forest to be sacrificed. This complaint might only be too true, provided the pulp industry is not combined with a rational forest culture and economizing. A word ofwarning is, indeed, in many places necessary, and the forest must, in regard to this matter, be cared for in such a manner that it will always yield a harvest, and every possible use must be made of all kinds of refuse. How many industries have been made practical and flourishing only by careful use of what is generally called "refuse?" It must always be borne in mind that just this refuse from

one industry easily might give rise to another. And it is to be hoped that even the vast amount of refuse in the wood-working branch, such as sawdust, etc., will be more generally utilized in an economical way than at present is the case.

The kind of wood mostly used for wood pulp in the United States is white spruce (*Abies alba*). A method practiced in this country is to mix the spruce pulp with a certain quantity of pulp from other kinds of wood, such as aspen or poplar, in order to add to its whiteness. These latter woods—American aspen (*Populus tremuloides*) and white poplar (*Populus alba*)—differ greatly from the corresponding European woods, of which *Populus tremula* takes a prominent place in Europe, not only for wood pulp, but also, especially in Sweden, for matches and match boxes. As a raw material for wood pulp in the United States is further used the wood from *Abies balsamea*, *Abies canadensis* or hemlock tree, *Thuja occidentalis* or white cedar, *Taxodium disticum* or cypress in the Southern States and *Pinus strobus* or white pine. It has been found that the soda and sulphate processes, which are nearly related, both using alkaline salts, are more adaptable for resinous and knotty wood, as the formed resinous soaps are soluble in water, whereas the acid processes, using for instance sulphite of lime or magnesia, only partially dissolve the resins. Hence it might be judged that the former processes would be more suitable for the Southern States with their more resinous kinds of needle trees.

Both the mechanical and chemical methods for producing wood pulp are in use in the United States, whereas the half chemical or the grinding of previously boiled wood there is not in use.

This seems to be the case also with the sulphate method, which is in great favor in Europe, especially in Sweden and Norway. The sulphite method is most common in the United States and gives a somewhat larger yield, or about 40 per cent, the soda process giving only 33 to 35.

The number of American exhibitors of wood pulp were few, only three representing the sulphite process and one the mechanical. The reason for this might have been that the pulp factories also manufacture paper and thus were represented in other divisions of the exhibition.

Among the exhibitors of sulphite cellulose may be mentioned Alphena Sulphite Fibre Company, Michigan, a branch of the International Sulphite Fibre Company, Detroit. This pulp was of very good quality, combining whiteness in color with evenness and purity, without raw splinters being visible in the sheet. Raw material is spruce; but also poplar, balsam fir, and pine is used. The wood is sawn into thin slabs of about one inch in thickness, which is of a certain advantage, as knotty substances thus are not cut into small pieces, but might be separated from the pure cellulose after the boiling by means of a straining process. As the lye only wants to act upon the pure cellulose and not upon the resinous knots, it can be kept weaker

in the boiler, or the treatment in general be more lenient; and as this pulp must be purer after the whole knots being separated, it is also whiter and easier to bleach.

Other American exhibitors of sulphite pulp were Piedmont Pulp and Paper Company, West Virginia, and Manufacturing and Investment Company, Appleton, Wis. Both these exhibits were of good quality. The former factory is using a special inside coating for the boilers, consisting of gypsum. The new boiler of iron plate is for this purpose filled with ordinary sulphite lye, which is then heated to boiling, when a solid crust is left, thus making a protecting, insoluble inside coating of gypsum and monosulphite of lime, and of about one-fifteenth to three thirty-seconds of an inch in thickness, or the empty boiler might be heated to about 212° F. and the lye afterwards put in, when the same result is obtained. This sediment, which always more or less appears during boiling, was at first considered detrimental, until it was found to be a good substitute for the ordinary expensive and never lasting lead coating. The Piedmont Company is using sulphur and limestone (dolomite) for the preparation of the lye. The time of boiling is twelve hours and the pressure is about 6 atmospheres. The daily production is 20 tons bleached or 25 tons unbleached pulp.

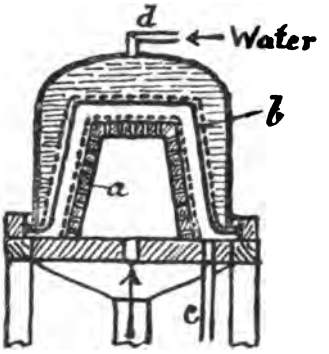


FIG. 47—Wood-pulp press.

The mechanical or in raw state ground pulp has during later years gained a special kind of utilization, which seems to promise a good future. There was a time when it was generally thought that this process, which is the oldest one, should be entirely overpowered by the chemical process. Far from this being the case, the mechanical wood pulp has more and more gained ground in the industrial branches. If we pass its large use for all kinds of inferior paper (newspaper, wall paper, etc.), we have still to consider its use in hardened state for all kinds of household articles and vessels. Already some ten years ago experiments have been made in order to form and press the pulp into different articles, and by certain processes make them sufficiently hard and resistive against pressure and liquids. The United Indurated Fibre Company, Fibrotta, N. J., has indeed shown what inventive power and perseverance of man can produce, and the great variety of articles exhibited by their factory and all manufactured from mechanical wood pulp indicates clearly that a grand industry here is opened.

It might not be out of the way to somewhat describe the general process in making these articles, and we choose a common water pail

as an example. The inner form is made of iron and perforated (Fig. 47*a*), covered outside with a wire cloth. Outside this form is a membrane of India rubber *b*, and outside this is again a wire cloth of a shape corresponding to that of the inside form. The pulp mixed with water is pressed in through the pipe *c* until the whole space between the inner form and the membrane is filled. Then water of high pressure is let in through the pipe *d*, which forces the pulp evenly against the inner form, the water going through the perforations. The table is then let down and the pail taken out for airdrying. The surface, especially the outer one, is very uneven and the whole pail of irregular thickness. It is therefore fixed on a chuck and while rotating operated upon by means of cutters or circular saws. Lastly the surface is finished by grinding until it receives a smooth appearance like leather.

Then follows the hardening process; the pail is dipped in linseed oil, which is easily sucked in by the still very porous material and heated in an oven to 300° F., and this process is repeated two to three times until the surface is brown, hard, and shining.

If a cut is made through the material, it will be found that the oil has penetrated from both sides, leaving a part in the middle untouched, the vessel thus being stronger by having a tough core with hard surfaces. By using a special method in this oiling and leaking process it is possible to imitate the graining of certain kinds of wood or the marble-like appearance of stone.

These vessels do not absorb water or ordinary liquids, not even by continuous use, and are not affected by milder acids or hot water. They are very strong, being made in one part, and very light, being thinner than ordinary wooden vessels. The price is about one-third higher than for galvanized-iron pails.

This factory, which received a very flattering testimonial from the jury, has during late years extended the business in order to make barrels and casks in the above-mentioned manner instead of making them from staves. It still remains to see how this difficult problem is to be solved. An ingenious idea which has been tried with success is to make use of the centrifugal force by putting the form with the pulp inside in quick rotation, when a compact, even layer is formed. The form might be perforated for throwing the water out. Other articles manufactured from wood pulp were exhibited, among which may be mentioned large boards intended for tables, panels, or similar purposes. Even doors might be made in this manner, which certainly would have advantage of not warping or shrinking, though on the other hand the difficulty of getting sharp corners must not be overlooked.

The Oswego Indurated Fiber Company, New York, exhibited bathing tubs of an elegant appearance, resembling porcelain, and manufactured from wood pulp; also parts of lavatories, water-closets, and cisterns, all of the same material and very white, hard, and glossy on the surface.

A very important question in connection with this industry is whether and to what extent refuse wood might be used for this purpose. It is to be hoped that with the development of this still young industry will follow a more diligent utilization of all kinds of wood refuse, so that not only comparatively good and young spruce wood is used, as at present mostly is the case.

Germany occupies a very prominent place in the wood-pulp industry. It can not be denied that the Swedish wood pulp, for instance, from Gysinge, is perfectly equal to the German as far as concerns the whiteness, evenness, and strength of fiber. But the latter exhibit was especially distinguished for its in the smallest details well-arranged and organized state, and for the circumstance that paper of superior quality, equal to that of linen or cotton and manufactured only from sulphite, was exhibited in connection with the cellulose. That paper for ordinary printing purposes or for inferior use generally can be made solely from chemical wood pulp is a well-known fact, but that the finest writing or drawing paper can be made from the same material must be considered as a novelty, and the honor of having shown this new product is due to the sulphite factory of Waldhof in Germany.

This factory, situated on the river Rhine, near Mannheim, is comparatively new, being founded in 1884 by Commerzienrath Dr. C. Clemm and Mr. C. Haas, who still continue to conduct, the one the technical, the other the commercial part of the business, and who have brought the industry to its present commanding height. The extent and importance of the establishment may be recognized from the following figures taken from the year 1892: Number of workmen and officials, 2,100; wood used, 6,350,000 cubic feet; coal used, 70,000 tons; pyrites used, 18,500 tons; limestone used, 6,000 tons; chloride of lime, 2,250 tons; daily production of dry pulp, 2,400 hundredweights. The last figure might be so expressed that if the annual production were manufactured into writing paper a meter in width, the rolls would seventeen times encircle the earth. The working power is received from 38 steam engines with a total capacity of 4,200 horsepower, which are fed by steam generators consisting of 42 boilers, with about 86,000 square feet heating surface.

The factory produces a first-class pulp, principally for the two following reasons: It has an abundant supply of pure water and cultivated spruce trees. Leaving aside the important question of highly developed and practical processes of manufacture, it must be evident that excellent raw material here plays a prominent part. And the forests at Waldhof are cultivated on scientific principles, consisting of regularly grown pines of the same age. The wood is, consequently, of more regular structure and without knots, thus making a white and even pulp. The general practice at sulphite factories is not adapted for the production of a first-class pulp, partly because the wood is of bad quality and partly because the size of the trees vary between very wide limits,

4 to 12 inches, the age varying between thirty and seventy-five years. When it is known that the quality of the wood, especially its hardness and strength, varies with the age, it will be easy to understand the great advantages of using cultivated trees for this purpose.

Although the factory is situated on the banks of the Rhine the necessary water is pumped from 57 artesian wells, in consequence of the frequent contamination of the river. Six engines, of about 600 horsepower, deliver about 7,700 gallons of water per minute.

The articles exhibited by this factory might be divided into three groups. The first comprises such materials as show the different stages of manufacture and ready-made cellulose; the second indicates different ways of utilizing the pulp; and the third shows how the by-products may be used in an economical manner.

In the first section were to be found all kinds of raw material, viz, spruce, partly in round blocks, partly in oblique cuts of one-half to five-eighths inch in thickness; further, limestone, pyrites, sulphite liquor, both in pure state and containing the incrusting matters in solution; and lastly, cellulose in cardboard sheets. The evenness and purity of the latter was shown by its being fixed in large frames and placed vertically in a dark room with a strong light behind the sheet, making it transparent. In this manner were exhibited bleached and unbleached wood pulps, and different kinds of paper made exclusively from wood pulp, some showing very fine watermarks (the German Emperor and imperial arms, the President and Vice-President of the United States).

A very interesting section was that showing the different ways of utilizing the pulp, among which paper making naturally took the most prominent part. And it was not ordinary cellulose paper, but the very finest kinds of writing and drawing paper, letter paper, copper-plate printing paper, etc., all manufactured exclusively of wood pulp as raw material. And, what was still more, the strength of this paper proved to be fully equal to that from best cotton or linen rags, which was displayed in a practical manner. Two rolls of paper, the one writing paper, the other wrapping paper, had weights suspended from them to indicate the strength. The former kind, weighing 0.016 pound per square foot, sustained a tearing strain of 18,000 feet, equivalent to 288 pounds, while the latter, weighing 0.018 pound per square foot, could bear a tearing strain of 29,500 feet, equivalent to 531 pounds. It can hardly be denied that this paper indicates a new stage in this industry, and it will almost seem probable that the rag has "seen its best days" in more than one sense.

But the cellulose is a material which might be used in many branches of industry. A very important one is that for nitration for gun cotton, which was exhibited both in wool and paper form. Further was to be seen cellulose prepared for the manufacture of collodion, for bandages (lint) and for surgical purposes; also woven materials, articles of

clothing manufactured by the Türck process, according to which the fibers are brought into parallelism by means of carding cylinders and afterwards spun to yarn and woven in ordinary manner. All these exhibited articles tend to prove that the Germans have their minds and eyes open for the introduction of new manufacturing branches. And still more are they worth our admiration when it comes to the utilization of the by-products. As is well known, the soda process is generally considered to have this advantage, that the spent liquors can be used again for the same purpose after evaporation and calcining, whereas the spent sulphite liquor has been considered valueless. The Waldhof factory has shown that this liquor can be used economically in several industries. Thus charcoal was prepared by evaporation and charring the residue and used for decolorization, calcium sulphite, ethylic alcohol by fermentation, and concentrated spent liquors for use as gum or glue. From the used pyrites was prepared zinc by the electrical process of Kittler and Diefenbacher, and purple ore (oxide of iron). Whether these different modes of utilizing the by-products have any future in prospect or have any commercial value might at present be difficult to state; but in any case they are worth consideration and ought to be further developed.

It can hardly be denied that Sweden from the very first beginning has taken a leading position in the technical development of the wood pulp industry by the introduction of simplified and improved processes. Already in 1857 the first pulp factory was founded at Trollhattan by a merchant, Mr. Francke, using Voelter's system, or grinding raw blocks against a vertical rotating sandstone. The Ekman process, using sulphite of magnesia for manufacturing chemical wood pulp, is well known abroad. The process which is at present most in use for chemical pulp in this country seems to be the sulphite, though in many places sulphate pulp is produced. In 1890 Sweden had 117 wood pulp factories, with a production of 223,000,000 pounds ground pulp, 52,000,000 pounds soda pulp, and 53,000,000 pounds sulphite pulp, or a total of 328,000,000 pounds dry wood pulp.

In Sweden, chiefly spruce, but also fir and aspen, is used for this purpose. The Scandinavian pulp has a decided advantage over that produced in more southern countries, the wood being not so rich in resinous matters, resulting in a more rapid darkening of the paper. Large quantities of pulp are exported, mostly to England, Germany, North America, Finland, and Norway. This export has steadily increased, as the following figures show:

	Pounds.
1872	12,758,000
1882	20,394,000
1886	55,460,000
1890	141,993,000
1891	190,393,000

The price has during this time fallen more than 50 per cent, so that the value of the exported pulp has increased from $365,000 in 1872 to $2,412,000 in 1891.

Sweden had good representants for wood pulp at the exhibition, viz, Gysinge and Laxo factories for sulphite pulp and Malmoe and Gustafsfors factories for soda pulp. Gysinge pulp was of first quality, which was acknowledged by all experts. It had a very white and durable color, great evenness even in large sheets, and was very pure and free from raw splinters. Another good quality consisted in its facility of bleaching, depending upon the purity. The fibers were both strong and tenacious, giving a soft pulp. Analysis of the pulp had shown only 0.4 per cent ashes, whereas 0.7 per cent is considered as normal in sulphite.

The Norwegian wood pulp was also of very good quality, representing both the sulphite and sulphate process, the latter using glaubersalt and caustic lime. The sulphate process is economical, as the spent liquor can be used again for the same purpose after addition of some sulphate. It gives a white and soft pulp. This kind of cellulose was exhibited by Ranheims and Moss factories, the former with a yearly production of 3,000 tons, the latter of 4,000 tons bleached pulp. Sulphite cellulose was exhibited by the following factories: Hunfos, Gjoevik, Boensdaleu, Skieu, and Skotselv, all of them, and especially Gjoevik and Skotselv, showing a pure, even, and long-fibered pulp.

Among other countries to be mentioned exhibiting wood pulp is Canada. This country had, in 1890, 31 factories for wood pulp, 24 of which had a daily production of 138 tons each. The principal raw material is spruce, but also pine and hemlock are used. Only one factory was represented, viz, Eddy Company, Hull, which displayed some specimens of mechanically ground wood pulp and household utensils made from this stuff by pressing.

Taken as a whole, it must be confessed that the exhibit of wood pulp at the exhibition hardly had such proportions as might have been anticipated from the importance of this industry, and several pulp-producing countries in Europe, such as Russia, England, France and others did not exhibit any products in this industry.

2. CHARCOAL, TAR, TURPENTINE, AND OTHER PRODUCTS OF DISTILLATION OF WOOD; GUMS AND RESINS.

Charcoal was exhibited by several countries and States, among which may be mentioned Russia, Sweden, Japan, the States of Michigan, Illinois, etc. The manner of producing this fuel was illustrated and described by several exhibitors. Though the principles are the same, the methods and means are somewhat different in different countries, and for the sake of comparison some of these methods may be described.

In Japan there are several kinds of kilns in use for burning charcoal, but the stone and earthen kilns are most common. The charcoal produced in the latter is moderately hard and seems to be more readily combustible, whereas the stone kiln charcoal is harder and more used in mines and factories. The earthen kiln is more extensively used.

This kiln is shown in figure 48. The kind of wood used is kunugi (*quercus serrata*), a species of oak. The time for cutting this wood is generally the winter, between the latter part of December and middle of February, when the farmers have more spare time and the sap is not running. The trees are grown in the same way as brushwood. The young shoots of about 2 feet in height are planted about 4 or 5 feet apart and are cut for the first time at three years old, after which shoots begin to grow from the stumps. The period for the second cutting varies with the locality, but is generally at four to seven years. The length of the cut pieces of wood is about 1 foot 1 inch

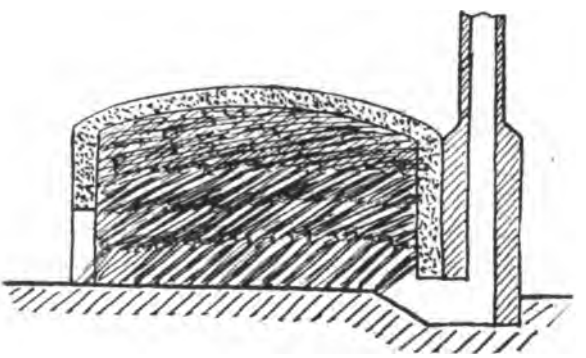


FIG. 48.

and diameter 2 to 3 inches. The material used for building the kiln is a natural earth found in the localities where the charcoal is made, and consisting of fine sand, a small quantity of clay with volcanic ashes and traces of lime. It is reddish yellow in color, from oxide of iron.

According to a description of the kiln shown in the Japanese section, the following is the method of building the same is following:

After the position has been chosen, an outline of the form of the bottom is drawn and a trench about 6 to 7 inches wide and 3½ feet deep is dug in the ground along the outline. The trench is then filled with mud, which should be hardened by stamping and pounding with a post. The earth inside of the inner boundary of the trench is removed and a hole is made in the back part for a chimney. From the surface of the ground, just above the orifice, a hole is sunk perpendicularly, with a pointed stick, so as to communicate with the hole at the bottom. This completes the foundation work. Next, the firedoor is made and the head or top is constructed by standing the wood a little obliquely, beginning from the back part, over which branches and twigs are heaped up horizontally, raising the middle a little higher than the rest. The whole is then covered with earth rendered plastic with a little

water and hardened by careful tamping and by burning small branches and leaves upon its outer surface after a fire door has been made within. A man with his head covered with a tenugui (towel) enters the kiln from the fire door, and another man, standing outside, hands him the wood. At first split wood or small wood should be set up on end, beginning from the hole in the back. The hole is then filled and some straw laid on the top and outside a layer of earth. Readily combustible twigs and leaves are heaped in the fire door and the fire is kindled. After burning ten hours the fire reaches the back part. Then the fire door should be closed with clay, leaving an orifice 4 or 5 inches square. The wood is completely charred after 12 hours, when the fire is extinguished by closing all the orifices. The ready charcoal is packed into bags or rushes, tied with ropes and of the same length as the charcoal.

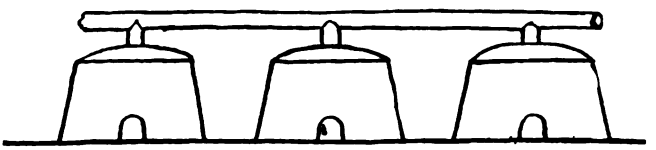


FIG. 49.

One bag of coal weighs about 25 pounds. A heap of wood 6 feet square and 3 feet in height is called a 3 by 6 feet date or cord, and a good burning should yield about 6 bags to one such date. The weight differs according to the kind of kiln used, old or new wood, good or bad quality, skill of the workman, and state of weather, generally 20 to 25 per cent of the weight of the wood. This earthen-kiln charcoal is called "Sakura."

The stone kilns are similar in construction, but built of stone or brick work.

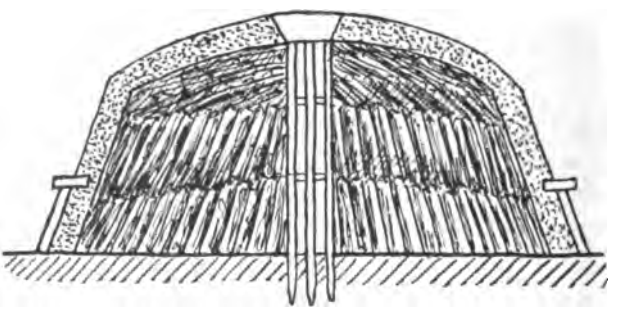


FIG. 50.

The Republic of Paraguay exhibited some good specimens of charcoal from not less than forty different kinds of wood. They were of small size, being intended for forging purposes. Among the trees represented may be mentioned Ananas, Acacia, Bacharis, Citrus, Eugenia, Larugondia, Mactura, Patagonula, Porkinsonia, Salix, Vitus.

The State of Michigan exhibited several products of wood distillation, viz: Charcoal (of maple), pyroligneous acid, wood alcohol, and wood tar. The kilns are of the shape shown in figure 49. The prod-

ucts of combustion are generally collected by means of a pipe at the top and led to a place for distillation.

Some good samples of charcoal were shown in the Swedish pavilion, exhibited by the Scanian vinegar factory, situated in the south part of Sweden. In this country the burning of charcoal is generally done in a kind of kiln (mila) shown in figure 50. The wood, mostly pine, is either laid horizontally or raised vertically, being cut into lengths of from 4 up to 10 feet, different lengths for different kind of kilns. In the middle of the kiln are placed 3 to 4 straight rods, tied together, thus forming a kind of chimney shaft. The wood is then placed all around, with the smaller pieces inside, then larger, and again smaller outside, the whole thus forming a round, somewhat conical heap. Afterwards shorter stumps, twigs, and branches are placed on the top and the whole covered outside with a suitable material, coal dust, or clay and sand. When the kilns serve for charring the refuse from sawmills, the covering is made from sawdust. Wooden supports are placed outside to keep this stuff in place. The kiln is then fired by letting down ignited wood, etc., from the top, after the making of holes all round the walls near the ground for draft. As the burning inside is increased, holes must be made through the covering on different places, and others must be shut in order to make the charring even and spread it to all parts of the kiln.

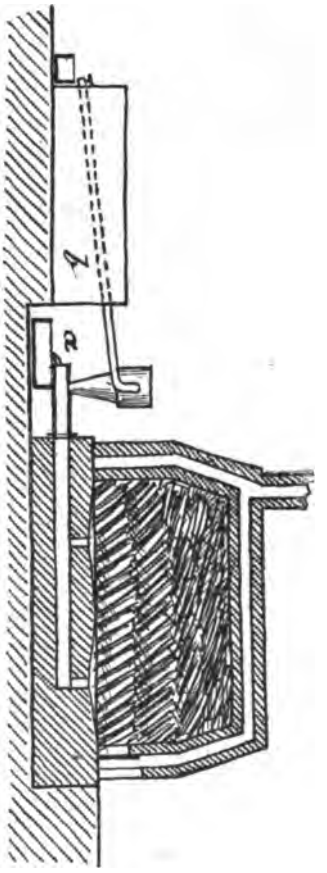


FIG. 51.

In several places are used furnaces, built of brick and connected with chimney shafts for draft. Also by-products (tar) might in them be received. These furnaces are more expensive (about $4,000), and produce charcoal of somewhat inferior quality to that burned in kilns, which makes it necessary that a large quantity of wood be at hand, thus making them specially useful at large sawmills. Their advantages consist in being fireproof, causing less charring costs and dispensing with skilled workmen.

Figure 51 represents a pitch-distilling furnace with apparatus for distillation of turpentine, such as is used in Russia. A model of this furnace was exhibited. The wood is placed in the inner room, which

has an opening, closed during the process with an iron door. Outside this room are two fireplaces, one on each side, the heating gases thus surrounding the inside room, and going out through the chimney. The wood generally used consists of stumps from pine trees, very rich in resin; or wood about 2 feet in length is used, split from trees about 6 to 8 inches in diameter. These pine trees, while growing, have been treated in such a manner that the bark has been peeled off, except at one place (see fig. 52), whereby the gums in the wood rise to the surface. By means of a scraper, "kossar," this crude gum is scraped off yearly, and, together with the chips, inclosed in cylinders of spruce bark, and in this shape sold in the market as raw material, "zhivitza," for preparing tar. The tree might thus be treated several times and still continue to grow, the yearly rings being formed only inside the bark.

FIG. 52.

During the distillation of the wood in the furnace (fig. 51) the liquids are running down through holes in the bottom into a pipe and collected at *a*, whereas the gases are condensed into turpentine by passing through a vessel *b*, filled with cold water. The residue in the furnace is charcoal.

Figure 53 shows the general construction of a pitch-boiling turpentine oven, also in a model shape exhibited in the Russian section. In the boiler *a* is placed the above-mentioned resinous material, "zhivitza," together with water. The boiler is heated from the outside by

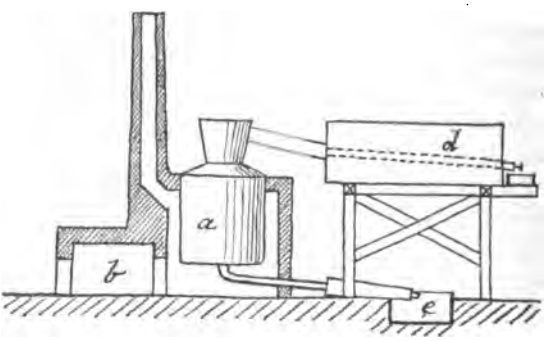


FIG. 53.

means of the fireplace *b*, when the tar runs down to the vessel *c*, and the gases are condensed by passing through the water tank *d*.

The products exhibited in connection with these models were the following: (1) Soot obtained by burning bark, epidermis, turpentine, and turpentine residue in specially constructed brick furnaces with flues, called soot-smoking furnaces; (2) tar, distilled exclusively from bark epidermis, peeled in summer from birches, Archangel Province (this tar was a black liquid, distilled in earthenware pots); (3) pitch,

dark-brown thick liquor, extracted in oven and obtained from the pine tree; (4) pek, black solid, produced by the boiling down of pitch; and pek oil, a dark colored liquid; (5) red turpentine (brownish-red), obtained during the boiling down of pitch into "pek;" (6) yellow turpentine, obtained in the same manner and precipitated by the action of the sun during an entire summer; (7) pale turpentine (almost colorless, thin), obtained through clarifying yellow turpentine by the aid of steam; (8) colophony, produced by boiling down "zhivitza" over slow fire; (9) turpentine (white, clear), obtained during the boiling down of "zhivitza" into colophony.

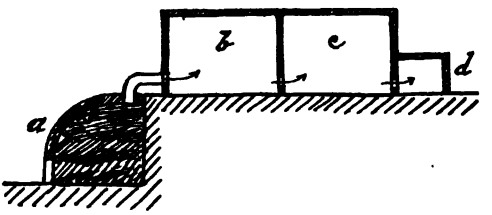


FIG. 54.

In the Japanese section was also shown a soot smoking furnace of a somewhat peculiar kind. This is shown in figure 54. This soot, called shoyen or haizumi, is obtained by burning pieces of the *mátsu* (pine tree). It is used by lacquer makers and mixed with shibu, a juice received from unripe persimmons, for blackening purposes. The kiln *a*, for burning the wood, is made of clay and gravel. The smoke passes through the rooms *b*, *c*, and *d*, on the floors of which the soot is deposited. Finest quality is received in room *d*, second in *c*, and third in *b*. The rooms *b* and *c* are about 18 by 30 by 16 feet high, built of wood and covered with clay; the room *d* is 3 by 3 by 4 feet high.

Japan exhibited turpentine oil from *Pinus densiflora* and *Pinus thunbergii*, which conifers give more oils than European trees. The resin is boiled in water, and the turpentine, which evaporates with the water, is then condensed.

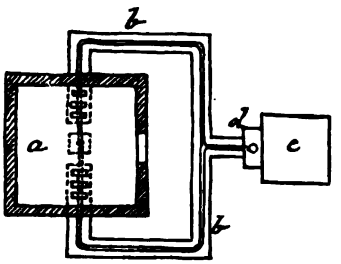


FIG. 55.

A very interesting plant for the utilization of all kinds of wood refuse was exhibited by Mr. J. Mathieu, Chicago, who also exhibited some good and useful products of this industry. Among these may be mentioned charcoal from yellow pine, chestnut, oak, gum, sassafras, and maple; further, creosote, pine wood tar, turpentine, and wood-oil pitch; and, lastly, acetic acid, wood alcohol, acetone, vinegar from maple wood, and oak and chestnut extract for tanning hides, all pure liquids. The arrangement of the furnace is shown in figure 55. The furnace *a* has central fire; the smoke products are passing through holes in the floor and led through pipes to a condenser *c*. The pipes are laid in a channel *b*, through which pass the gases, which are not condensed, being driven by means

of a fan, *d*, back to the central opening in the furnace, in order to supply air for the burning process. By this system, always using the same air, already heated, economy in the process is obtained, as well as by letting the air from the fan pass outside the pipes, thus absorbing their heat.

The process of turpentine orcharding, as ordinarily practiced in the United States, was shown in the Government building. By means of a scraping and cutting tool (fig. 56) the bark is peeled off in the manner shown in the figure and the resin gathered. This method of "tapping" or "bleeding" is very wasteful, as the trees can be worked only four years. The wood used is generally long-leaf pine. The resin is distilled and furnishes turpentine, and the residue (resin or colophony) is used for the manufacture of soaps, varnishes, axle grease, etc. The orcharding in France seems to be less wasteful to the forests, being practiced in the manner shown in figures 57 and 58. The cut ought to go through the sapwood. In France the wood is cut to a smaller depth at first and afterwards deeper.

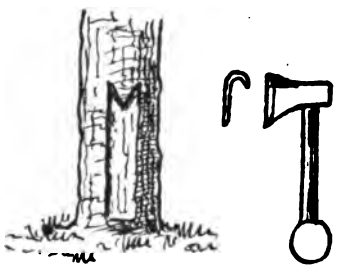


FIG. 56.

The Japanese section showed to full advantage that the intelligent people of Japan understand how to make the best possible use of wood for smaller industries. One of this latter is the producing of lacquer juice, which is received from urushi (*Rhus vernicifera*). This tree is planted at the foot of mountains or in fields. When the tree is 12 to 13 years old the juice may be extracted, which operation begins in the latter part of June, ending in October. If the stem is 8 or 9 inches in circumference incisions are made on one side of the stem at a distance of about 2 feet above the ground, the incisions on the other side at about 3½ feet above the ground. If the stem is larger the incisions can be made on three sides. After determining the places to be incised, the outer bark should be scraped off, but not too deeply. Horizontal cuts are then made in these places, which cuts are of different length, forming the shape of an hourglass (fig. 59). Each incision is about 0.3 inch from the next. If the juice exuding from the cuts is not scraped off at the proper time it will overflow, and the

FIGS. 57 and 58.

incisions are likely to dry up, and the exudation of the juice is retarded or prevented. The juice will generally cease to flow after four or five days.

Camphor oil is received from the root of the camphor tree (*Cinnamomum camphora*). The root is cut in small pieces, which are heated in a vessel, from which the vapors are led through cold water and condensed.

Vegetable wax was also exhibited by Japan. This is received from the seed of Urushi (*Rhus vernicifera*). The fruits are collected and the seeds rubbed off from the stalk. Then they are beaten in a mortar to separate the outer part (containing wax) from the kernel and afterwards winnowed. The whole is placed in a steaming tub for heating, then put into a cloth bag and pressed between rollers. This wax, "Moku-ro," is pure and white and of good quality.

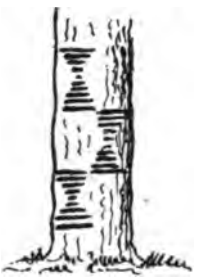


FIG. 59.

A peculiar kind of wax was exhibited, viz, the Ibota wax, which has been manufactured in Japan since ancient times. In old Japanese records it is stated that the "Chuhaku-ro" (insect wax) is found on the Nezumimochi (*Ligustrum-japonicum*) and the Ibota (*Ligustrum ibota*), but now it is mostly found on the Jonerico (*Fraxinus pubinervis*). In summer the insect deposits the wax upon the small branches to the thickness of about 0.2 inch, the branches appearing as though covered with white flour. These branches are cut in autumn, the wax is scraped off, boiled, and dissolved in hot water, and then filtered through a bag of coarse cloth and put in cold water, when it congeals.

Several other minor industries were represented in the forestry department, such as basket, wheel, cask making, etc. But they are all of such nature that they seem to more properly be arranged under the manufacture department.

NOVA SCOTIA FRUITS AND FRUIT-GROWING.

BY

B. STARRATT.

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Annapolis Royal, formerly Port Royal, is perhaps the oldest town in North America. It is beautifully situated at the head of the Annapolis Basin and at the southwestern extremity of the Annapolis Valley. This valley extends to Windsor, its extreme northeastern limit, a distance of 80 miles. Its width is from 5 to 15 miles. This is the garden of Nova Scotia, the center of the fruit-growing district, rich in marshes and orchards, though apples are successfully grown in many other parts of the province. The Windsor and Annapolis Railway runs its entire length, with branches from Cornwallis and Lunenburg, the former rnnning through a highly cultivated and wealthy fruit-producing section, and the latter extending through an excellent farming district to the south shore on the Atlantic. Apples were first introduced by the early French settlers and some of the apple and pear trees are still standing and bearing fruit in Granville and Grand Pre. The latter village is the scene of Longfellow's poem where "Gabriel, the son of Basil the blacksmith," and "gentle Evangeline lived," surrounded by "fields of flax and orchards and cornfields."

After the expulsion of the French Acadians in 1755, invitations were sent by Governor Laurence, of Acadia, to New England, offering the abandoned farms of the French to American settlers. Accordingly three delegates, Bent, Felch, and Evans, were sent by Governor Phipps, of Massachusetts, to "spy out the land." After spending some time in the valley they returned giving favorable reports of the richness and fertility of the soil. The next year about seventy families came and settled on the south side of Annapolis River between the Mochelle and Nietaux streams, occupying vacant farms. Many of these farms had small orchards, or at least a few apple and pear trees attached. The new settlers, pleased with the change from the poor gravelly soil of Massachusetts to the fertile fields and marshes of their new homes, introduced modern and improved methods of cultivating, and many of them set out orchards, grafted out the old French trees, and thus gave a great impetus to orcharding.

One of the three delegates, David Bent, great grandfather of the writer, selected one of the finest farms for himself; came down with the new arrivals and settled on that farm, where he set out a large orchard.

The soil being exceptionally deep and rich, the trees grew rapidly, and now at this date, one hundred and thirty years later, it is one of the largest and finest of the old orchards in the valley, some of the trees having attained immense size and are yet sound and vigorous,

producing large crops of fruit. Many of these trees bear Rhode Island Greenings.

The farm is still owned by descendants of the original David Bent. One of the sons, also named David, went back to Lexington, Mass., and married Ruth Parker, the youngest daughter of Capt. John Parker, who led the rebel squad against the Redcoats in the skirmish of Lexington. He returned to Nova Scotia with Ruth and settled at Belle Isle, across the river from his father's farm, where he lived, prospered, and died. The Belle Isle farm is yet owned and occupied by his discendants.

Apples, pears, plums, cherries, and small fruits are successfully grown in the Annapolis Valley. Peaches and grapes succeed in some favored localities, some of the hardier varieties doing well; the former are remarkably fine. The principal apples grown are the Gravenstein, Ribston, Baldwin, King, Golden Russet, and Nonpareil. These are the commercial shippers, though there are about 200 varieties cultivated. The Nonpareil has long been the principal variety grown in the county of Annapolis. It is supposed to have been originally brought from France and during all these long years has maintained its supremacy. It is remarkable for its long-keeping qualities and hardiness, resisting the attacks of disease and insect pests in a wonderful manner. It has lived to see many of the newly introduced and highly vaunted varieties which threatened to supplant it abandoned and grafted out, and is to-day the most popular and highly valued apple in the county. It commands the higest price and is much sought after by English shippers. It is now, at this date, February 15, 1894, selling from the cellars of the farmers for $4 per barrel.

A favorite apple for many years in this valley has been the Yellow Bellefleur, or, as it is locally known, the Bishop Pippin. It obtained the latter name from being introduced by Bishop Inglis on his farm in Aylesford and from thence spread to other parts of the valley. It is one of the finest dessert apples in this country when in perfection, being at its best in February. It is of very fine grain and is noted for retaining its flavor in a remarkable degree. It is, however, extremely susceptible to the attacks of insects, and of late years has become almost worthless owing to the scab, so much so that whole orchards of that variety, formerly yielding immense crops, have been grafted out and other and more modern kinds substituted.

None of these, however, with the exception, possibly, of the Gravenstein, have ever yielded so abundant crops as the Yellow Bellefleur. It is hoped, by means of spraying, that the insect pests may be subdued, when this valuable apple will be again cultivated.

A great many Baldwins are grown in Nova Scotia. They are great yielders in alternate years, the trees often breaking down beneath the heavy loads of fruit. They do not color quite so highly as in New England, are dry and flavorless, but sell well in England.

Of all the apples grown none excel in flavor the Ribston Pippin. It grows to perfection in this country and obtains the highest price in England. Its extremely high flavor and crispness make it very popular with English consumers. But it is a slow grower, is a long time coming into bearing, and is a shy yielder. Of late years its culture is being gradually abandoned.

The most advanced pomologists, however, believe the celebrated Gravenstein to be the king of apples. The soil and climate seem exceptionally adapted to the culture of this favorite apple. It attains a rich, juicy flavor in the valley, besides being high colored and possessing, for a fall apple, good keeping qualities. It is a favorite apple with American consumers, and coming into the Boston and New York markets after the American Gravensteins are all gone, it commands good prices. It has never taken well with English dealers, not being sufficiently ironclad to stand the rough handling of so long a journey, yet producers hope that its showy table and dessert qualities will eventually win over the conservative Englishmen.

Pears succeed well, but are little cultivated for commercial purposes, a few trees in the garden for home use comprising the bulk of the pear industry. The principal varieties grown are Bartlett, Clapp's Favorite, Louis Boune, Flemish Beauty, Sheldon, Seckel, and the old French Belle.

There has been a great boom in plum culture within the last few years, paying perhaps better than any other branch of horticulture. Black Knot has been somewhat troublesome, but not to any great extent. Principal varieties, Moore's Arctic, Lombard, Niagara, and Abundance. The latter has been recently introduced.

Large quantities of cherries are grown at Bear River, in Digby County, and are shipped to St. John. Great numbers of people from the surrounding country drive to Bear River during the cherry season, and "Cherry Sunday" has become an institution.

Very much attention has been directed to the small-fruit culture in some localities, and with very satisfactory results. There is a growing demand at paying prices.

The principal market for Nova Scotia apples is in England, London being the port to which they are mostly sent, Liverpool, Glasgow, and Hull taking a few. They are chiefly shipped from Halifax by the Furness line of steamships, the freight from any of the stations along the line of the Windsor and Annapolis Railway to London, including transshipment at Halifax, being about 4 shillings sterling per barrel.

The first apples sent to England for sale was forty years ago, trial shipments having been made by B. Weir, of Halifax, and Ambrose Bent, of Paradise. These were sent by sailing vessel, were sold in Liverpool, and netted $2 per barrel—a fair price for those times. Thirty years ago the writer commenced by making a shipment of 50 barrels from Halifax to London; result, a total loss. The year follow-

ing two carloads were sent from Annapolis, with the same result. This was followed by a shipment from Halifax of 400 barrels, netting a profit of $520. This was shipped in January, my proceeds not coming to hand till March, two months afterwards. All these shipments were by sailing vessels. A partnership was then formed with Mr. Bent, under the name of Bent & Starratt, which continued for a quarter of a century.

Apples are packed and barreled by the grower, and either shipped by him on his own account through local agents to the fruit brokers in Pudding Lane or Covent Garden market, or sold to local buyers, occasionally foreign buyers from England or the United States putting in an appearance. In some seasons large quantities of Gravensteins are sold to United States buyers for the Boston and New York markets, and at satisfactory prices. An occasional cargo is shipped from Annapolis and Hautsport by tramp steamers.

A few years ago an effort was made to establish a line of steamers to carry apples from Annapolis to London direct. An expensive pier and warehouse were built, but the venture did not prove a financial success. An evaporator was also built and operated for a couple of years, but has fallen into disuse.

Formerly large quantities of cider was made, but of late years farmers believe that it pays better to feed the refuse fruit to stock.

A school for instruction in horticulture has been established at Wolfville. Prof. E. E. Sevile, a graduate of Ames Horticultural School, Iowa, is in charge. The Nova Scotia legislature has granted a liberal sum for its support. This school is in connection with Acadia College, and has the use of class rooms and laboratory in the college. This important movement marks a new era in the history of fruit growing in Nova Scotia, and provides a course of instruction in scientific horticulture that will prove of great value to fruit growers in the valley. The school was opened in December last with about 70 pupils. It is decidedly popular, many of the farmers in the vicinity, with their wives, sons, and daughters, being in attendance. Tuition is free.

This valley is destined to be a great fruit-producing country. Everything tends in that direction. Desirable fruit farms are being sought after by English farmers, who with ample means and skilled methods will rapidly develop the business.

The superior character of the fruit, its fine flavor, its firm, crisp, and long-keeping qualities, make it especially suitable to withstand the rough usage of transportation and change of climate incident upon shipping to England, where it is so well and favorably known, and where such satisfactory prices are obtained. This must tend to develop and increase the cultivation of the apple, and the time is not far distant when the whole valley, from Windsor to Annapolis, will be a continuous and unbroken line of orchards.

THE FURS.

BY

EDMUND R. LYON.

THE FURS.

By Edmond R. Lyon.

The business of manufactured furs, or the use of fur skins, is one of the oldest industries in existence, dating back to the sacred records of the Bible. Articles made of fur were and are worn by savages in cold climates to protect them from the chilly blasts, and also those in warm climates to conceal their nakedness; but apart from the uses of fur skins at a very early date, costly furs served for purposes of luxury and adornment. As Exodus tells us, the outer coverings of the Tabernacle in the Wilderness were adorned with the skins of the badger, but which later Biblical authorities have decided were the skins of the now world-wide fur seal, as badgers were then unknown in Assyria, Palestine, and Arabia. Fur skins were the medium of money among the tribes of the Arctic countries, and in the United States the beaver skin passed as currency with the early Indians.

In the twelfth century the habit of wearing furs became so general that all classes of society tried to outvie each other in the expense, so that Richard I of England and Philipp II of France prohibited the wearing of furs either by the princes or people; but such was the fascination of the people for furs that Louis IX of France appeared in public with a surcoat lined with ermine, which fur had always been associated with royalty. Later on noble families of Germany, France, and Italy were allowed the privilege of wearing a single kind of fur, and were also permitted to put the figure of the animal producing it on their armorial bearings, so that the squirrel, the marten, the sable, the beaver, appeared on the coat of arms of some of the highest aristocracy of continental Europe.

The Skinners Company is one of the oldest guilds in England; it ranks sixth or seventh, taking precedence with the Merchants Tailors Company of other years. This company was originally a company of furriers, or fur traders, but there is no document from which the date of foundation or particulars can be traced; as near as can be ascertained the first charter was granted by Edward III on March 1, 1327; it prevented the selling of old fur for new by skinners. Another charter, granted in 1437 by Henry VI, regulated the expense for sale of furs, mixing old and new furs, and the general scrutiny of all

works, business, and wares. Charles II granted a further charter in 1667, giving them jurisdiction of the manufacture of furs and skins, the manufacture of muffs and linings for garments, gloves, etc., with special care to foster the trade in domestic furs.

Many centuries ago the Baltic Sea was the great depot for fur trade, the tribes bringing down large quantities of furs from the North to the markets of Moscow and Novgorod, but the discovery of America started a new field of traffic, and although such furs as marten, ermine, and sable were brought from Siberia and northern Europe, the opening up of our forests and waters brought forth countless numbers of skins of mink, beaver, raccoon, lynx, skunk, marten, muskrat (or, as the Indians called it, musquash), fisher, wolverine, and the larger fur-bearing animals, such as the buffalo, the wolf, and all the species of the bear—black, brown, cinnamon, and grizzly—the traffic in which was monopolized for a century by three or four great trading companies. The Dutch East India Company was the first, and then afterwards the Hudson Bay Company; these corporations had agents over parts of the country where the animals were the most numerous, and purchased them mostly from the Indians, but this became all scattered by the march of progress and civilization, the iron horse pushing the trader, who had embraced the business of dealing in raw fur skins, to the doors of the post traders' hut, and vied in competition from the Indians for the product of his hunting, and as Dame Fashion decreed furs should be worn, hunters became more plentiful, and what the rifle did not bring forth the trap did, and all kinds and varieties of fur animals were killed and then brought to the factories of the manufacturers, or exported to other foreign countries, till to-day the capital invested in the United States in the importing, exporting, dealing in and manufacturing of furs is, in New York City alone, $8,032,134; the amount of wages paid per annum being $2,824,731, and the value of the product produced $10,663,990.

In all the natural fur-bearing animals whose skin is of a commercial value, especially those used for the producing of ladies' or men's wear, the degree of value is, first, quality; second, color, and third, size. Quality is, to a great extent, dependent upon the mildness or severity of the winter. If it is a cold winter the best fur is produced, and by this is meant that the under pile of the fur is thicker, closer, and finer, the pelt sounder, and the skin altogether in what is termed a prime condition, and in a mild winter the reverse. In some instances, should the winter be extremely severe, the streams continuously frozen, and the ground covered with snow, the animal's fur is apt to be coarse and thin, owing to the loss of his obtaining proper food and nourishment. The above is proved by the fact that the higher the altitude (and therefore lower temperature), the finer and richer the fur. It is also well known that cold countries produce the next element of value in the

color of the fur. This is exemplified in the fur of the mink, found in North America, as the skins from Maine and all of the British possessions are darker, finer, and fuller furred than those found in any other part, and the same may be said of the fur of the marten and Russian sable. Expert fur authorities claim that the nearer the equator the darker the hue; but this has a great many exceptions in the Alaska red fox, as the same animal is found in Russia; and, in fact, the writer does not agree with this opinion, as the Canada beaver is the darkest species, and in some of the far northwestern States the fur is of a pale cream color. The density of forests also tends to render fur darker and finer, as the animal is protected from the extreme rays of the sun and the extreme blasts of cold. It is also found that, like some game birds, the particular food obtained by the animals tends to make the fur fine and silky and much superior to the same animal which obtains or lives on a different kind. For example, a skunk inhabiting the tobacco growing counties of Pennsylvania and feeding on the leaves (though the size is not increased), the fur is of jet black, extremly fine, and bluish brown underneath, while those that feed on other substances are not as black and are coarser in fur.

We have now had quality and color. The next is size. All animals as they inhabit toward the poles increase in size, and those that have a wide range of country are larger. This is caused by the fact that having a great deal of ground to cover in search of food, produces bone, sinew, and muscle, and correspondingly larger specimens.

The sex of fur-bearing animals are supposed to be the same, with the exception of the Alaska fur seal, who, although being polygamous, the proportion of young is equal, as the young bachelors, or those males who have not any mates, congregate separately, as also do the females, before and after the breeding season. The enormous number of fur skins imported in this and foreign countries would astonish many readers. Some quantities are, however, stationary, while others are on the decrease. Animals of a seemingly domestic nature increase with the settlement of the country, as with the cultivated fields they can procure food more readily, and should the skin be not commercially wanted their numbers are very much augmented, while those animals who build their houses and feed near streams or waters are decreasing with the reclamation of the lands by the settler; hence the collection of the beaver and muskrat is very much less than in former years, in fact the former are about being exterminated in the same way as the American buffalo, which is practically exterminated, by the settling of a great deal of open prairie and country.

Fashion decrees in a measure the prices and quantities of furs. Should any fur be in demand, the eagerness of the dealer to obtain those skins is quickly heard of in the section or sections where this fur is most caught, and the trapper will try and get more skins than

he did in the year when it was not so much desired, likewise neglecting other skins not so much wanted. It has often happened that a certain kind of fur will be fashionable for quite a period till the quantity decreases to such an extent that fashion will discard it, and therefore give the animal a chance to recuperate and increase, till time brings it back again for use, when the animal, who in the meantime has been neglected, will have become plentiful.

The various kinds of fur-bearing animals used commercially and found in North America are the following: Mink, otter, skunk, beaver, red fox, cross fox, gray fox, kit fox, silver-gray fox, muskrat, wolverine, fisher, raccoon, opossum, rabbit, wolf, grizzly bear, black bear, brown bear, cinnamon bear, buffalo, badger, musk ox, sea otter, and fur seal. Several of the above range from the Atlantic to the Pacific, some only in certain sections, and some all over. The varieties mostly used to-day for manufacture into articles for female wear are the mink, the marten, the skunk, the fur seal, and the opossum, natural and dyed; and for men's uses the raccoon, which also is manufactured into sleigh and driving robes and overcoats, as is also, and for the same purpose, the various species of the bear, wolf, and foxes; and for both ladies' and gents' uses the beaver, wolverine, fisher, badger, and muskrat are also used, but only in limited quantities.

A very large percentage of the fur skins caught in North America, including the Hudson Bay collection, are annually exported to Europe. The number sold in London from November, 1892, to May, 1893, was as follows:

Mink	220,653	Bear	23,326
Muskrat	1,758,693	Beaver	59,507
Raccoon	264,876	Rabbit	50,281
Badger	4,344	Otter	13,436
Skunk	253,430	Sea otter	1,598
Opossum	158,705	Fisher	7,801
Marten or sable	154,450	Fox	128,103
Wild-cat	3,961	Musk ox	883
House cat	12,512	Wolverine	1,860
Wolf	2,039		

while the number of skins of those caught in Europe and Australia was nothing compared to ours. These skins are mostly all sold at public auction in London, at one of the large sales rooms, the sales occurring in January (mostly for some of the collection of the Hudson Bay Company), March, June, and October. The value of these skins is very large, amounting in some years to as high as $5,000,000. The sales are generally, especially the one in March, attended by buyers from all over the world, but the method of selling is different to that in our country; the goods are all catalogued without reference to where they come from; the bids are all silent and are given by a

movement known in some instances only to the auctioneer, and where the fur is in active demand and the quantity not large, the fluctuations are very wide, a rise of 40, 50, or 60 per cent frequently occurring, and vice versa, if not wanted or neglected, a fall of a corresponding ratio.

The fur-seal skin, of which so much has been said, and so widely advertised, and given rise to so much controversy, has many varieties, as follows: The Australian, the Crozet Island or South Shetland, Cape Horn and Cape of Good Hope, Lobos Island, Alaska, Northwest or Victoria, Copper Island, Robbin Island, and Japanese. The skins, with the exception of those from South America, are all sent from San Francisco via New York to London in casks, packed in salt in bundles of forty or fifty skins. The skins are sorted into sizes, viz: Middlings, middlings and smalls (supposed to be 5 years old), smalls (4 years old), large pups (3 years old), middling pups and small pups (2 years old), extra small pups and gray pups (1 year old), of which the following quantities were sold in November, 1892: 7,554 Alaska; 31,380 Copper Island, belonging to Russia; 22,350 Northwest coast or the poached skins, 834 South Sea Island, 592 Cape Horn, 2,470 Lobos Island, 482 Australasian, 1,659 Victoria, and in January, 1893, 39,862 Northwest coast, a total of 106,000 skins for the consumption of the world in the year 1893, of which 62,000 skins were those taken by the sealing fleet in the waters of the Bering Sea, or nearly two-thirds of the entire catch.

From the figures given of the fur animals caught in the United States, it will be seen that North America furnishes nearly all the furs that are manufactured and worn, and it is a source of a very large revenue to the various States where they predominate.

The process of tanning or dressing is the method by which raw skins are prepared before being manufactured into articles of apparel or other uses. The art of dressing skins belongs undoubtedly to the Indians in all countries; our own Indian is the best dresser of fur, especially of the buffalo, as a skin that is Indian dressed is superior to "white men's tanning." The art of tanning is probably unknown to them, but we have borrowed the fundamental process and have improved upon it by the aid of skilled workmen and machinery, of which, however, very little of the latter is used. The usual way of dressing a skin is to first scrape off every particle of fat from the pelt of the skin until the latter is perfectly clean (herein the Indian excelled, as when he skinned the animal he did it so dexterously that all the fat was removed at that time); after this the skin is allowed to soak in some lye until the pelt is soft, when it is washed and tubbed, and then shaved or passed over a knife that is held firmly in an upright position and all particles of fat removed; but this must be done skillfully so that the pelt is not cut, nor the grain split, which

would cause the fur to loosen; from this they are buttered, placed in a barrel with clean sawdust and tramped by men half naked, the heat of the body rendering the leather soft and pliable; when this part is accomplished they are smoothed, carefully beaten out and finished by again putting them in a lighter, which cleans them thoroughly; then removed from this, and put pelt to pelt ready to be manufactured.

The American fur dressers are the best for all of their own animals; the English excel in chinchilla, marten, and sable, while the German has no superior in dressing the Siberian squirrel. A great many skins are dyed, as the natural color would not admit of their being manufactured. The astrachan and Persian lamb, whose color is generally black, is slightly dyed, so as to darken the pelt, which would show white on a black surface. The Germans are the best dyers of the above, as they give the skins brilliancy of color and fineness of pelt. The French are the most expert dyers of their rabbits, and have brought this article dyed to a great state of perfection, so much so that no other nation attempts it.

The act of dyeing fur skins is as ancient as the world, but it has never proved a successful industry in America; whether for the reason that our workmen have not mastered the art or our water has not the chemical properties; it is probably the latter, as many furriers have imported dyers who, when here, did not have the success that is obtained on the same skin finished by them in Europe.

UNITED STATES EXHIBIT.

The advancement made in the manufacture of articles of fur clothing, as compared with prior exhibitions and former years, is very great. Much praise should be accorded and the highest consideration given to those exhibitors who comprise the fur groups in the United States section of the manufacturers and liberal arts building. It would not be amiss at this time to say that the American furrier of to-day excels every other nation in the skillfulness of his work, the stylish effects produced, and the costly value of the material used. Each manufacturer of furs in the United States vies with the other in producing exceptionally well-made and well-matched articles for men's and women's wear, both as to the gradation of color of the fur skin used and to the evenness of the height of the fur.

The exhibition made by the house of C. G. Gunthers Sons, of New York, ranks preeminent for their great care in manufacture and exclusive originality of designs.

Relative to the remarks in this article regarding the advancement made by the manufacturer of to-day as against those of former years, the greatest exemplification of this is the splendid exhibit made by the house of H. Liebes & Co., of San Francisco, and also that of John T. Shayne & Co., of Chicago, the former being one of the largest handlers of fur seals in the world, also holding one of the largest interests

in the company that has the concession from the United States for the taking of fur seals on the Pribilof Islands, while the latter, by their push, energy, and sagacity, have risen to a foremost position. In former years the West was no factor in the manufactured fur business, although being a large emporium for the sale of raw fur skins, but to-day large quantities of manufactured furs are made and sold in nearly every large Western city. Messrs. H. Liebes & Co., of San Francisco, exhibit some choice fur-seal jackets, capes, ulsters, and overcoats of most excellent workmanship and novelty of design.

Mention is due the following fur manufacturers of the United States for the superior excellence of the products exhibited: A. E. Burkhardt Company, of Cincinnati, Ohio; The Wolf & Periolat Company, of Chicago, and George C. Treadwell & Co., of Albany, N. Y.

RUSSIA.

A very important exhibit has been displayed by the brothers P. M. and E. M. Greenwald, of St. Petersburg. The interest of this exhibit consists in skins of a number of animals which are to be found only in Russia or Siberia—as certain kinds of squirrels, sables, fitch, deer, cat, etc. Great attention is paid to the dressing of the very rare skin of natural black fox.

NEW SOUTH WALES.

New South Wales has displayed a great variety of material and ways of preparation. The boas, opossums, and platypus furs exhibited by the Woman's Work Commission, Sydney, are of greatest originality.

CAPE GOVERNMENT.

Cape Town has shown great skill in tanning skins of angoras, silver jackals, and leopards.

DENMARK.

Denmark has displayed examples of fine treatment of eider downs in the exhibit of C. A. Trall, Copenhagen.

SWEDEN.

The exhibit of Tarsells & Co., Stockholm, excels in treatment of blue fox, spotted otter, and brown marten.

As a whole we are pleased to state that the examination of the fur display of the World's Columbian Exposition has shown that the industry is practiced on a large scale in all countries, and that they all excel in attaining the highest degree of skill in the treatment of the specific animals which are proper to their climate and to their natural conditions.

GOLD AND SILVER MINING: THE ACCESSORIES, PROCESSES, ETC.

BY

WILLIAM P. BLAKE.

GOLD AND SILVER MINING: THE ACCESSORIES, PROCESSES, ETC.

By WILLIAM P. BLAKE,

Fellow of the Geological Societies of London and America; Author of the Report upon Precious Metals at Paris, 1867; Professor of Geology and Metallurgy in the University of Arizona, and Director of the School of Mines, Tucson, Ariz.

PLATINUM AND ALLOYS OF GOLD AND SILVER.

Under this group, which comprised also some other metals, there were two extremely interesting exhibits, one by Mr. George F. Kunz, of New York, consisting of platinum, platinum earth, concentrates, etc., with photographic illustrations of the processes of extraction in Siberia, and another by the firm of Tiffany & Co., of New York, showing all the principal alloys of gold and silver. The firm, also, of Johnson, Matthey & Co., of Hatton Garden, London, made a superb exhibit of platinum and the associate metals, both in their crude state in ingots and manufactured.

EXTRACTION OF GOLD AND SILVER BY MILLING.

EXHIBIT OF FRASER & CHALMERS.

The exhibit of mining and metallurgical machinery made by Fraser & Chalmers occupied the largest space assigned to any private firm in the mines building and was located in the southeastern corner. It was an exhibit which attracted much attention, being novel to the great mass of visitors who were unfamiliar with metalliferous mining and ore treatment. But to the interests which it practically concerned one of the most characteristic features of the exhibit was that it was not novel but standard. The ephemeral crop of gold-saving devices had no showing within the inclosure. The machinery shown was not of the order which promises to save the world's gold in the future, but with slight modifications in detail and a general advance in weight and capacity it was just such machinery as has been saving the gold and silver of the world obtainable through vein mining for the past quarter century or more.

STAMP MILL.

Only five stamps were shown as an index to the many thousands built by this firm. These were heavy stamps, and their ponderous action was illustrated at intervals by dropping them in the usual manner, but upon cushions of wood instead of as usual upon the ore above dies in the mortar boxes. The splash of ore was lacking, but the action was otherwise complete. In the stamp mill the ore is usually brought in at a high elevation, broken with a Blake or Comet crusher, and passes to Tulloch or Challenge feeders, which deliver it automatically to the stamps, which are ordinarily arranged in sets of five in a mortar. These stamps are operated by means of cams and tappets, and make their beats in such a manner that, when a stamp drops, its neighbors are already at rest, thus giving greater effect upon the ore, as two at rest hold the material solid while the one that drops gives the blow. This process goes on continuously with the five stamps in each mortar. The stamps crush the ore to a fine pulp, which passes through screens and over amalgamating plates which are of copper, sometimes silver plated. The screens are of fine-mesh wire cloth, or of Russia iron, steel, or other suitable metal punched with needle slots for the passage of the pulp when it has been pulverized to the requisite fineness. The exhibitors received an award for this modern stamp quartz mill on these grounds:

Excellency of workmanship and material; improvement in shoes and wearing parts; improved wooden guides which can be easily removed from any stamp, while others in the same battery are working.

Also for their silver-plated copper table, on the grounds:

It is constructed by special machinery to insure a perfectly smooth surface. It is made of soft, pure copper, and electrically coated with silver, making an excellent polished plate for saving free gold.

This saving is secured by coating the plate with mercury, which has an affinity for the passing particles of gold, forming with them an amalgam which adheres to the plates and is removed at intervals. The plates are set at a gentle inclination, so that the pulp will flow slowly over them.

In milling practice in some parts of the world the whole brunt of breaking up rock is put upon the stamps, and no automatic feeders are employed, but the more usual and economical practice universal in America is to employ rock breakers and automatic ore feeders. For many years the breaker employed has been of the Blake type, with a straight jaw movement, and very great pressure obtainable by the use of toggles. On this type of crusher the exhibitors obtained an award on grounds stated as follows: "The improved cheek pieces on each side of the swinging jaw of the Blake crusher form a seat for keys which can be removed when worn. The Blake in its usual form

is a coarse crusher. The action of an eccentric upon a shaft lifting a pitman which brings into play toggles on either side bearing on one side in a fixed frame and on the other in a massive swinging-jaw piece which closes upon a fixed jaw piece. The swinging jaw being pivoted considerably above the point of greatest closure, there is at this point quite a movement, so that the product is not as finely graded as in the modified type known as the Dodge crusher (and also exhibited), in which the pivotal point of the jaw is below and close to the point of the greatest closure. The product is therefore finer, but for stamp mills the Blake crusher is better adapted. Where a large quantity of coarse product is required a crusher of the gyratory or Comet type is employed. This has a conical crusher head gyrating inside a massive hopper of an inverted conical form. The jaw in this case may be described as circular and the operation of crushing goes on continuously, the point of greatest closure passing around the circle.

"The ore feeders operate by intermittent movement, which always appears more curious to a casual observer than a continuous movement. A tappet rod, with rubber bumper, is struck in the descent of stamps, and this in the Tulloch feeder causes a vibrating movement of a tray below the hopper of the feeder, so that at every vibration a portion of the ore is allowed to fall into the tray and be pushed by a gate or scraper until it falls into the stamp mortar. The Challenge feeder, preferred for wet ores, employs the tappet actuating a friction feed, which causes an intermittent rotary movement by the alternate biting or engagement and letting go or disengagement of the feed parts. Bevel gears communicate this movement to a revolving disk beneath the tray and the ore is thus scraped into the stamp mortar by regular installments."

The differences of practice in stamp milling constitute a science which has been very fully presented in a series of papers by Mr. T. A. Rickard before the American Institute of Mining Engineers. The chief distinction in practice is between the long slow drop and the short quick drop, the former often designated as Gilpin County (Colorado) and the latter as California practice. With the long drop the mortars are usually deeper, and the mesh of screens is finer, so that the ore remains longer subject to the action of the stamps.

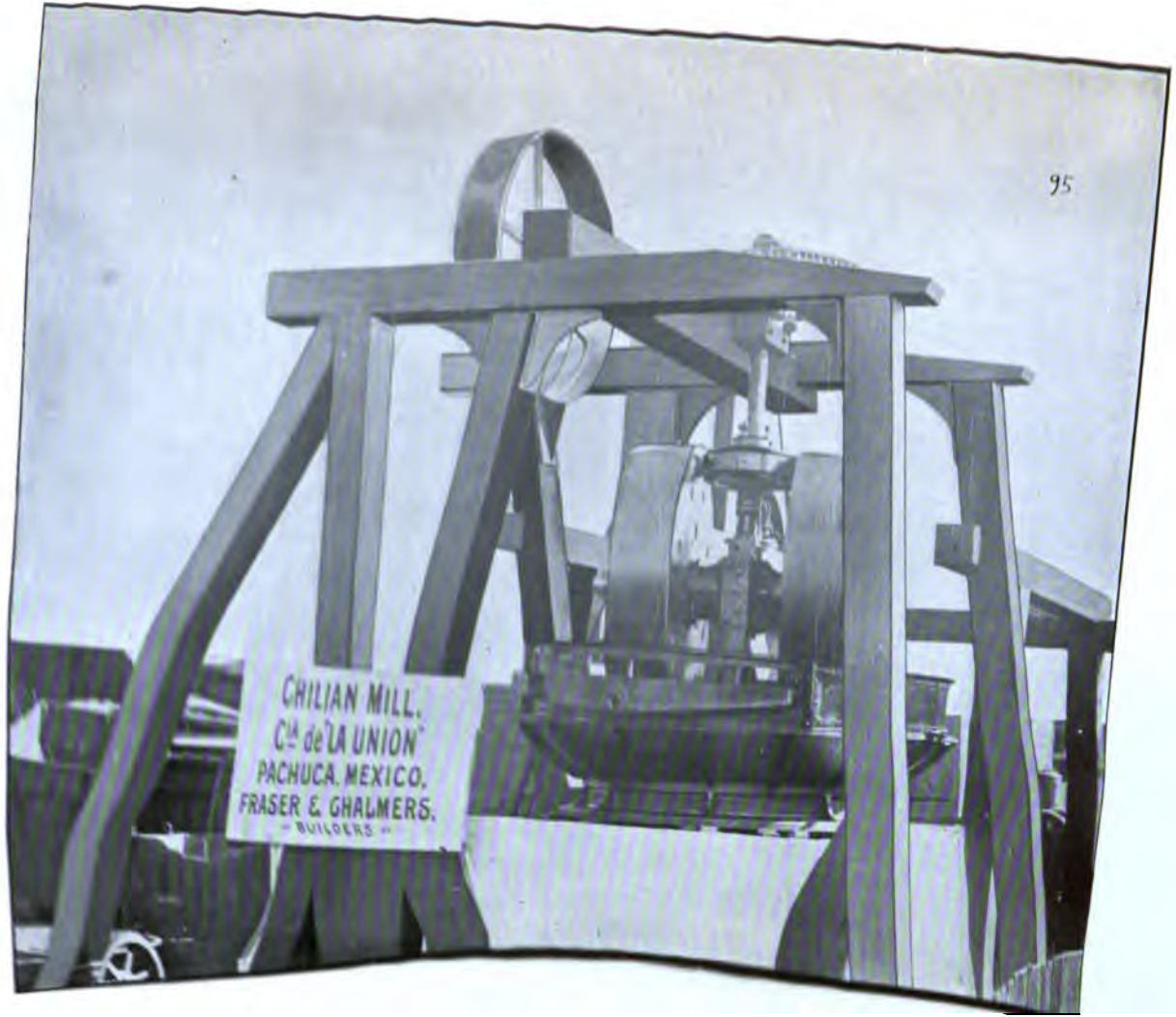
The guide bushings for stamp stems are of wood, and it has been found that wood framing in point of endurance, elastic quality, and general desirability is still better than iron for the service required in stamp mills. The tremendous incessant shock to which the acting parts in stamp mills are subject is unusual in machinery, and inevitably destructive. Stamp stems made of the best obtainable steel lose elasticity and break after extended use, being practically worn-out by internal stress, while there is no wear on the exterior. This, however,

is not a matter of great expense, as the stems are made of such length that they can be turned and returned and used over many times, the breaks being near the head and close to the end of the stem. The material for shoes and dies is the subject of much study. If it be not well chosen, it will not only break, but be swagged or caused to flow by the hammering, so that faces will be cupped in great cavities. A good material will wear with even faces, as cupped faces impair the duty of the stamp mill. The force of the clause of award, "improvement in shoes and wearing parts," is thus apparent. The best material is a proper forged steel, but by reason of lower cost and the availability of used-up parts for remelting, cast iron is much employed, it being also a question in which the character of ore must be considered. Stamp cams are often keyed upon the shafts, but a new device has been introduced, originating at the El Callao mill, Venezuela, known as the Blanton cam. In this a small circular wedge pinned upon the shaft takes the place of the key, and the cam, while readily removable, is found to bite the shaft in action with a never-losing grip. This Blanton device is much more convenient than keys. The mortars are made to suit the character of ore, commonly with screen and discharge for pulp on one side for gold ores, and on both sides for silver ores. A variety of types were shown, including the sectional mortar, which received an award in the following terms:

Sectional mortar for mule-back transportation.—It is constructed of steel and cast iron and its combined weight is 5,000 pounds. It is made up of many pieces, none exceeding 300 pounds in weight, and is easily and rapidly put together and taken apart. The distribution of metal is the result of many experiments. It is put together so exactly that its life is longer than if it was cast in one piece, and it is easily transported over the trails in the mountains. The angle of the screens also is the result of years of experience. It is made of fine material, and the workmanship is excellent.

Machinery of other kinds is also sectionalized, including large Corliss engines. The usual limitations for sectional machinery are, in weight, 300 pounds for muleback and 150 pounds for a llama or a man. Cylinders are completely sectionalized and pillow blocks and caps may be readily sectionalized. Cranks, connecting rods, and the first pieces of crank shafts for large engines may sometimes be allowed to exceed 300 pounds, and boiler tubes are transported full length, although the usual limitation for length is 8 feet. If the circumstances require it, however, machinery of any weight and engines of any power likely to be required may be so sectionalized as to be carried over the most difficult mountain trails. Mr. Eschevarria, superintendent of the Pinos Altos Bullion Company, Limited, writes of a 16 and 28 by 36 inch compound Corliss engine (250 horsepower) furnished by Fraser & Chalmers for his company.

The sectional engines have given entire satisfaction, and have been the cause of many remarks made by visitors how such mammoth machinery could be brought by animals over such rough mountainous trails.


CHILIAN MILL.
Cia de "LA UNION"
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FRASER & CHALMERS.
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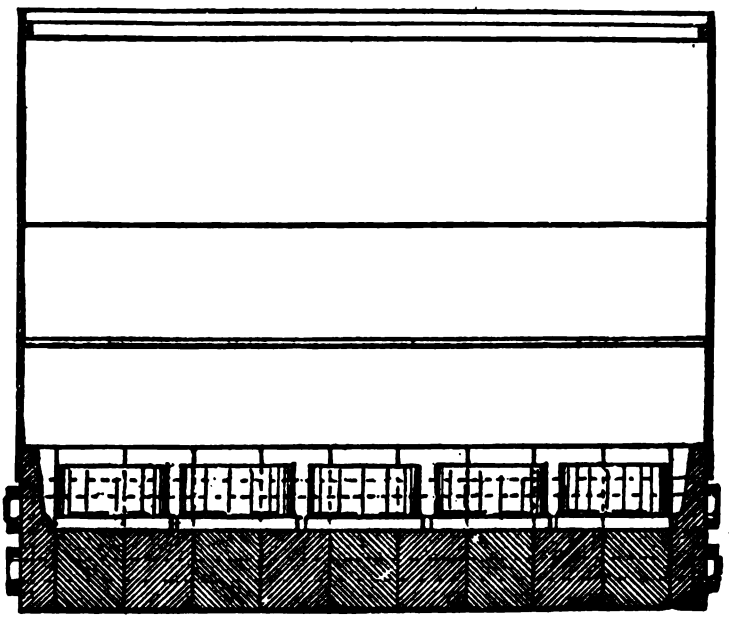
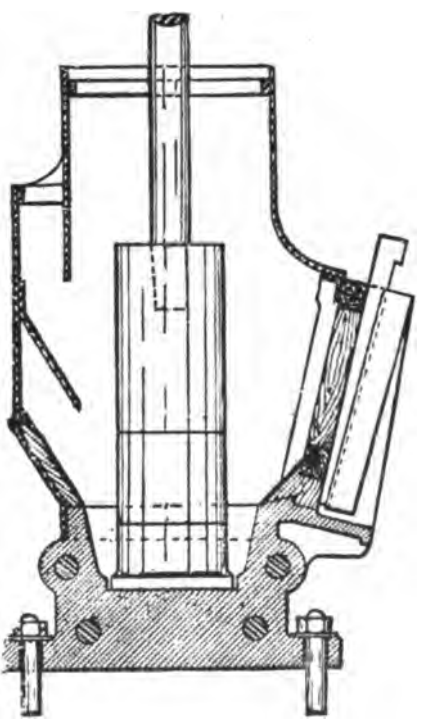




Sectional mortar.

HUNTINGTON CENTRIFUGAL QUARTZ MILL.

Alongside the stamp mill as a worthy competitor was shown the Huntington mill, similarly arranged with automatic feeder and table of silver-plated copper plates. The ore feeder was operated by a shaft instead of a tappet, the same intermittent action of the friction feed in the Challenge feeder being easily obtainable. The mill was shown in working motion. In its operation a vertical crosshead driven by gears carries around with it four hangers, from which depend as many crushing rolls, which pass around inside of a ring die in a pan-shaped mortar or receptable. Into this the partly crushed ore is fed pulverized by the rolls, and when sufficiently fine is forced out through screens to a dischage passage, from which it descends to the amalgamating table. It should be remarked here that in the stamp mill amalgamating plates are also commonly hung inside the mortar, and mercury is also fed into the mill for amalgamating purposes. In like manner mercury is fed into the Huntington mill, but of the quantity and other details everything depends upon the character of the ore.

It is usual in charging a Huntington to put into the mill every twelve hours about three times as much quicksilver as you are getting gold.

The ring die is placed, and the rollers revolve at such a height above the bottom of the mill as has been found to obtain the best action in pulverizing the ore, amalgamating the precious metals, and discharging the pulp. The question naturally arises: When is the stamp mill and when is the Huntington mill to be preferred? This question does not admit of very definite answer. So many conditions, such as extent of investment, character of ore in point of hardness or ease, or difficulty in gold extraction, fineness of crushing expedient, etc., are to be considered, so that the same judgment must be exercised as would be required to determine the manner of running a mill. For some purposes, such as recrushing tailings in concentrating mills, the Huntington is preferred to stamps, and it is also largely used in smaller plants and for ores of medium hardness, while in the large mills in which great quantities of hard low-grade ore have to be crushed rather coarsely stamps are generally used.

The Huntington mill received an award as follows:

It is strongly built, occupies but little space, it is cheaper than a stamp mill of the same capacity, and it granulates instead of rubbing.

CHILIAN MILL.

An award was received by Fraser & Chalmers for their improved Chilian mill, being expressed in the following language:

Well built and of good material, especially the cast-steel tires, also the novelty of a self-feeder Chilian mill.

The "Chilian mill," so called, was first simply comprised in a pit in the ground with bottom and sides of stone, and rough stone rollers

attached to wooden sweeps which were driven by horse power. Later iron bands were put on the stone rollers and plates of iron were placed in the bottom to form a track for the travel of the rollers. From the clumsy construction it was necessary to place the rollers a considerable distance apart, and the sides being nearly vertical, it was difficult to keep the material under the rollers until it was all pulverized. To accomplish this a boy was often placed in the machine with a rude shovel, whose duty it was to constantly push the material under the rollers as they revolved. The manufacturers claim that their improvements have trebled the effective capacity of the Chilian mill, and from a crude device have changed it to a very perfect and effective machine. They called attention: First, to the peculiar shape of the bowl or mortar of the machine. It is easily seen that, owing to the curved sides of the mortar, the pulp, when set in motion by the action of the rollers, will flow easily and naturally up to the discharge screen, and at the same time the particles that are too coarse to pass the screen will fall by gravity again under the rollers. Second, to the placing of the rollers so close together, or, more properly, so close to the center that as they revolve they at the same time are turned or, more properly, twisted on the track. As the rollers weigh about 5 tons each, it will be apparent that this twisting motion has transformed the crushing force also to a rubbing force that assists to a great degree in reducing the ore to powder. When the rollers were placed farther from the center there was much less of this rubbing action, and consequently the machine was more of a crusher than a pulverizer, depending almost wholly on the dead weight of the rollers to reduce the ore. Third, to the scraper that travels with the shaft and constantly forces the pulp in front of the rollers. The closeness of the rollers to the center makes it possible to do this perfectly. Fourth, to the construction of the driving-shaft mechanism. Formerly mills of this class were so constructed that the rollers were mounted on a shaft that ran rigidly through each roller, forming the axle on which they revolved. The center of this shaft or axle was so constructed that it formed an enlarged opening, which was fitted over the driving shaft in such a manner as to allow either end to be raised without binding or cramping the driving shaft. This was for the purpose of allowing the rollers to lift when any substance was under them which was too hard to be crushed at once by the sheer weight of the roller. While this answered the purpose it was a very faulty construction, as when either roller was lifted above the level of the other it had the effect of canting both rollers, and consequently reduced the effective crushing surface of each roller. The improved mechanism employs a suitable driving-head for the shaft. This driving-head carries crank axles, giving each roller a separate flexible bearing. The construction enables either roller to lift several inches vertically, still standing

perpendicularly and without in the least affecting the other roller. Fifth, to the material used, which is that found to produce the best average results. The false bottom or roller track is made of the hardest of chilled iron, and the roller ties are of rolled tire steel, which is so tough and homogenous that the wear is perfectly uniform, keeping the face of the roller always true and in shape to do its maximum work.

These improvements have brought a crude device up to a most perfect and effective machine, and from a former nominal capacity of 8 or 10 tons daily these Chilian mills are now crushing as much as 18 tons per day, all of which will pass an 120-mesh screen. There is no single machine connected with the reduction of ores where a series of improvements have produced such decided good results as are shown in the every day working of this Chilian mill.

The Chilian mill has an approximate average capacity of 15 tons per day of twenty-four hours, and each mill requires 6 horsepower. The process from the time the ore enters the mill until turned into bullion is as follows: The ore passes through a crusher into an ore bin, and is fed by means of a Challenge feeder (the same as with stamps) into the Chilian mill. The pulp is then flushed, without the use of screens, into settling tanks, where the surplus water is drawn off. It is then charged from the tanks into the barrels, each barrel (having a capacity of 5 tons) being then heated; and, after the chemicals (blue stone, zinc, and salt) have been introduced, the barrel revolves for a period of from twelve to twenty hours, it being necessary to experiment on different classes of ore as to the most profitable length of time to keep the charge in the barrels. The charge is then discharged into spouts and washed into settlers, and the amalgam therein collected in the usual way. The percentage of saving in the barrels is approximately the same as in the "Patio" process, and without the same loss in quicksilver; in all the different tests that have been made between barrel amalgamation and the Mexican "Patio" process, the percentage has been slightly in favor of the barrel process in the saving of silver and quicksilver. We enumerate briefly the advantages claimed for the Chilian mill and barrel process over stamps.

First, the Chilian mill crushes the ore to a fineness of 120 mesh, thus freeing all the small particles of metal from the quartz, so that on amalgamation it readily amalgamates with the quicksilver, while stamps ordinarily crush through coarser than 60-mesh screens. In this point alone there would be at least 10 to 20 per cent more metal freed from the quartz than with the stamps. Second, to attain the above results, with a good engine, only one-half the power would be necessary to work the Chilian mill to crush the same amount of ore to 120 mesh that is required with stamps. Third, another great advantage of the Chilian mill for crushing over that of stamps on the average ores

found in Mexico and worked by the Patio process is that the wearing of the shoes and dies contribute a deal of iron to the pulp, which is in most cases detrimental to amalgamation, as it fouls the quicksilver, making it slower in its action. This point has been thoroughly demonstrated at the different districts in Mexico, i. e., states of Durango, Zacatecas, and Bachuca, where this process is in operation, where Fraser & Chalmers have several large plants of this kind. On the other hand, with the Chilian mills the amount of iron worn in powdering is less than one-sixth, and the consequences proportionately favorable to amalgamation after the ore passes through the Chilian mills. Fourth, another important feature is the simplicity of construction of the Chilian mill and low cost of repairs, as the life of the wearing parts required to be replaced in the Chilian mill is about two years, these parts amounting to 18,000 pounds for each mill, and requiring no skilled labor to operate them.

After numerous tests made in Mexico on different ores the estimated cost, including crushing, grinding in Chilian mills, settling in tanks, amalgamating in barrels, including chemicals and loss of quicksilver, and the turning of the silver into bullion, has been found not to exceed $4 Mexican money per ton (1893), in a good-sized and well-designed plant, with a capacity of, say, 80 tons per day.

FRUE VANNER CONCENTRATOR.

We have so far considered machinery for the crushing and pulverizing or reduction of ore, and the amalgamation of the particles of gold and silver in the resulting pulp by the action of mercury. Ores in which this action is sufficient are called free milling. They constitute, usually, the upper portions of ore bodies, or those portions near the surface, or so far weathered or acted upon by oxidation and displacement of sulphur that the gold and silver are readily amalgamable. Ores are refractory or refuse to yield their gold and silver to this method on account of various elements in their composition, but chiefly because pyritic. Such ores require to be smelted or else treated by wet process with chemicals; chlorine and cyanide of potassium being the chemicals most commonly employed, each according to the nature of the ore. Ordinarily the gold in an ore is disseminated through the pyrites in which it is refractory and other materials of the vein in which it is free-milling. The process of amalgamation being cheaper than the methods of treating refractory ore, the whole quantity of ore is crushed, and all the gold that is amalgamable is saved by that method, leaving the lighter, worthless gangue and the heavy sulphides containing refractory gold. It becomes necessary to separate these two elements, saving the precious materials for smelting or other treatment and discarding the great bulk of refuse matter with the least practicable waste of gold. This process is concentration, and the

machine most in vogue for this work upon gold and silver ores is pre-eminently the Frue vanner.

This machine is a fine concentrator, treating finely-pulverized material as compared with jigs which are used on coarser material, especially in the concentration of minerals containing the baser metals, such as lead, copper, zinc, and tin. For a further description I present the following quotation from the catalogue of the manufacturers, Messrs. Fraser & Chalmers:

The vanner was the result of a long series of experiments in the concentration of silver ores, carried out from 1872 to 1874 by the late Mr. W. B. Frue, assisted by Mr. W. McDermott, who has ever since been identified with the introduction of the machine. The special object of the experiments was the treatment of low-grade silver ores of the Silver Islet mine, on Lake Superior, and Mr. Frue's long experience in the dressing of copper in the Lake Superior region determined him to attempt concentration. Many forms of jigs, shaking tables, and belts with various motions were tried, and in the end a side-shaking traveling belt was evolved, which, even in the experimental stages, gave exceptional results.

Before going to the expense of building a mill several practical working tests were made on larger belt machines of different designs, and to make doubly sure the Silver Islet Mining Company employed Messrs. Adams and Carter, of San Francisco, to carry out working tests by amalgamation process as against concentration. These gentlemen had had a large experience in the amalgamation of silver ores in Idaho, and believed that this process would prove more successful than concentration. The necessary full-size pan, settler, and agitator were brought, and a long series of working tests on various grades of ore was made. The record of these experiments, when compared with those of the concentration tests on the then crude vanner, completely satisfied Messrs. Adams and Carter of the superiority of concentration on the particular ore treated, and, further, of the large field for the improved concentrator on gold and silver ores generally.

It may be mentioned incidentally that a 50-stamp mill with 24 vanners was afterwards built at the Silver Islet mine. It paid for its cost of erection in about four months' run, and was used at intervals for a period of seven years whenever ore of low grade had accumulated. In this mill 5-ounce silver ore was often treated to a good profit, notwithstanding very high charges for smelting the rich concentrates produced.

The great step in advance of other concentrators made by the vanner was the treatment of a stamp-mill pulp at one cheap operation, with the production of absolutely clean concentrations and with surprisingly low loss of value. A material which in Germany would be divided into at least three classes and treated on at least six machines was treated at once on a single machine and cleaner concentration produced than from a number of combined treatments. In making this statement we are well acquainted with the perfection of German dressing works and their developed science of concentration; and we are also aware that, with the classes of ore treated in Germany and the local conditions governing subsequent treatment of concentrates, the advantages of the vanner can not be considered from the same point of view as in this country. With labor and fuel, transportation and smelting as high as they are in the United States, rapid automatic treatment is a necessity for tailings or low-grade ore. The only objections that one ever hears urged by men of experience against the vanner are that it is "slow" and needs exact "adjustment;" and new concentrators keep coming out which are both "fast" and not "delicate"—can be run by a child. These objections are inherent in the work to be done, not peculiar to the vanner. For finely crushed ore rapid treat-

ment and close work are utterly incompatible, as every slime dresser knows. As to adjustment, the very fact that the vanner is automatic and continuous implies that it must be adjusted right to its work and kept under the same conditions. To illustrate this very simply, watch a man tending one vanner in a mill where engine speed or water supply is irregular. Every change of speed of engine or volume of water needs a corresponding change of machine either in water or belt travel. Next step into a mill, as several may be seen in California, with sixteen vanners running like a single piece of clockwork and one man keeping a general eye over them while handling the concentrations produced. The two cases answer all objections as to complication and difficulty of adjustment; in the first, one man is driven wild watching a single machine; in the second case, one man has an easy job looking at sixteen machines, which are treating 80 to 100 tons of ore every day. It is the unfortunate experience of all machinery builders that they can not add brains to their machines to supply the absence of the same useful material in many men who run the machines.

To make a condensed popular description of the action of the Frue vanner we may say that it is comprised in an inclined, endless, rubber belt moving over rolls mounted upon a frame which has a side-shaking motion. The upper side of the belt ascends and water and pulp being fed upon and distributed over it in proportions determined by experience, the side shaking together with the downward flow causes a separation of the material, the heavy particles adhering to the belt and being carried upward and deposited in concentrate boxes, the light particles or gangue, not adhering to the belt, being carried downward by the flow of water and removed by means of a launder. This action, properly managed, is found to effect a very nice separation of the concentrates from the tailings. The rate of movement of the belt can be conveniently adjusted by speed cones. The driving of the head roller is effected through a spiral spring which permits the side shake. The belt has a rim to retain the material at the sides, and is supported by a number of small rollers so as to form a smooth, slightly inclined plane for the work of concentration.

The exhibit included two Frue vanning machines arranged with reference to stamps and Huntington mill, respectively, these vanners having plain belts 6 feet wide. Also a 4-foot vanner of an improved type using Morse patent corrugated belt. The award received on account of this vanner reads simply:

It is one of the best concentrators in the market; of good workmanship and material.

This affords no explanation of the very peculiar merits of the improved belt machine which, working in combination with machines of the plain-belt type, effects a great saving, increasing capacity so greatly as to reduce the number of machines required and enabling those that are used to be employed with closer results. The means, too, are simple, little more than the employment of the corrugated belt at a higher inclination than the plain belt. The corrugated belt is more expensive, but on some ores the amount of material handled can be

doubled by this means alone with equally close results. The finest use of the corrugated-belt machine is probably in connection with plain-belt machines, the material being first passed over the corrugated belt, which, by its elevation and rapid work, permits of such a precise handling of water supply and preparation of the concentrates that the following vanners can do very fine work. The use of hydrometric sizers before the vanners is also a great advantage in fine concentration.

SMELTING FURNACE.

Having followed the ore through the processes of milling, amalgamation, and concentration we come to that of smelting. This applies not only to concentrates from these stated processes, but also, and very largely, to ores with no prior treatment except crushing and roasting. The furnace exhibited was a lead-smelting furnace, and it should be said that the smelting furnaces peculiar to copper manufacture, including converters for bessemerizing copper matte and all their appliances, are built by Fraser & Chalmers. If space did not permit the showing of these copper furnaces, their products were at least in evidence in the beautiful exhibition of copper in every stage from the ore to the most refined product shown by the Baltimore Copper Smelting and Refining Company in the same inclosure.

Roasting furnaces, necessary for the treatment of ore preliminary to smelting and chlorination, are extensively manufactured by Fraser & Chalmers, but the limitation of space did not admit of their exhbition.

Relative to lead smelting the exhibit was an improved 42 by 100 water-jacketed lead furnace, which received an award on the following grounds:

First, the improved sectional water jacket, allowing constant water circulation through the sections; second, the alarm slag-escape attachment, which gives instant warning by an escaping blast.

We think that we can not do better than to quote the description of this exhibit written by Prof. H. O. Hofman for the Engineering and Mining Journal:

In the southeast part of the ground floor the well-known firm of Messrs. Fraser & Chalmers, Chicago, Ill., has its extended exhibit, of which the lead-smelting apparatus forms but a small part. The sampling of ores is represented by 2 crushers—a Blake, 15 by 9 inches, and a Dodge, 8 by 12 inches—intended to crush the ore from the mine for the Bridgman mechanical ore sampler. This machine, which came on the market only a couple of years ago, belongs to that class of sampling apparatus which takes the sample at short intervals from the whole width of a running stream of ore. Two types, called A and B, are exhibited. The former, of wrought iron, occupying a floor space 3 by 4 feet, and 7 feet 6 inches in height, gives 2 samples, the original and duplicate, thus furnishing an important means of controlling the operation. It has a capacity of from 15 to 25 tons of ore per hour, and is easily cleaned. Type B is a small machine of cast iron; it occupies a floor space of only 18 inches square, and is 36 inches high. It gives a single sample, and is used for cutting down either the main sample from machine A after it has been recrushed by

rolls (the exhibit shows a pair of geared rolls 10 by 16 inches) or small amounts of finely crushed ore. Its capacity varies from 2 to 4 tons per hour. These machines have found much favor, and with reason, where they have been introduced. A sample grinder of the well-known coffee-mill pattern concludes the list of sampling apparatus. The smelting is represented by an imposing, full-sized blast furnace 42 by 120 inches, a size much in use to-day. The jackets are cast iron and of six different patterns: front 2, back 2, side 1, and tapping jacket 1. A late improvement is to connect the jackets either in pairs or all together by means of short pieces of 1-inch pipe inserted below the water feeders and joined by rubber hose, the advantage of the device being that if the jackets are all connected no single one can ever run dry, and if in pairs the danger is greatly lessened, as, if the water inflow of one jacket, for some reason or other, is insufficint, it will be supplemented by its neighbor. The crucible of the furnace is inclosed in the usual cast-iron plates, strengthened by ribs. The slag spout shows an improvement in being water cooled, an interesting feature if we consider the amount and character of charge furnaces have to put through to-day. A beautiful device, which must strike every smelting man with pleasure as soon as he looks a little closely at the furnace, is the Davies slag escape, as it is so simple, convenient, and useful. It consists in an opening in the under side of a tuyere pipe or tuyere box closed by a linen or paper diaphragm. As soon as any slag entering the pipe or box touches the diaphragm it burns a hole in it, and the noise of the escaping blast calls the attention of the keeper to the accident as soon as it has occurred. The accessory apparatus are represented by 2 Root positive blowers Nos. 6 and 7, which have, respectively, a displacement of 42 and 65 cubic feet of air per revolution; the former machine is driven by a horizontal engine, the latter by a vertical engine resting on the same bedplate. A typical slag pot 24 inches in diameter, 16½ inches deep, with wheels 24 inches in diameter, having straight spokes and steel roller bearings and several molds holding about 100 pounds of lead, comclude the list.

FINE-CRUSHING ROLLS.

A distinction in ore treatment is made between materials requiring to be finely pulverized, as by the action of a stamp mill, and those which are only to be granulated or reduced to particles of approximately graded size, avoiding fines. This is the case in coarse concentration, in which ore is crushed gradually and the values are separated from the gauge in as coarse form as possible, saving expense and difficulty. Also in dry as distinguished from the usual wet crushing in the preparation of gold ores for roasting and leaching, or of ores for smelting where fines are to be avoided. Several sets of rolls were shown, the geared rolls for coarse crushing and the Eckart rolls for fine crushing (these terms being relative), which are run directly by belt at a higher speed. This machine was thought deserving of an award.

Exhibit, W. R. Eckart's fine-crushing rolls. Award, excellence of the 9½-inch shaft and core cast in one piece, with a hole through the shaft, thus solidifying and improving the casting. For the adjustable distributor to equalize the wear of the rollers.

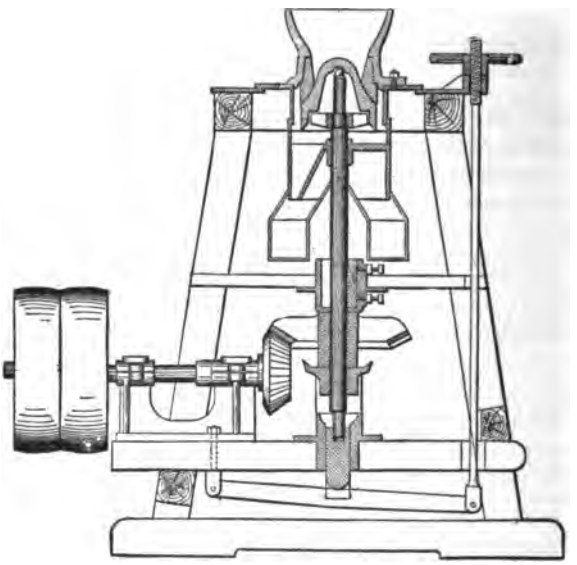
SAMPLE GRINDER.

Apart from the general course of processes but indispensable in every well-equipped mill is the sample grinder. This is a machine exhibited and well described by its name, having a small hopper at the

bottom of which is a grinding head revolving upon a vertical shaft driven by gears, with directing spouts under the grinder to receive the material treated. The importance of this machine lies in the necessity of constantly testing the material treated, whether raw ore or material partly concentrated or refuse tailings, to ascertain what values are contained and to guard against loss. Samples are therefore frequently assayed being first ground.

The following description of the construction and use of these sampling machines is quoted from the Engineering Magazine:

The new automatic ore-sampling machinery invented by H. L. Bridgman, and being placed on the market by Fraser & Chalmers, has been very profitably employed at the works of the Chicago Copper Refining Company for the past two years.



Sample grinder.

The matte and ore are unloaded by hand from a railroad car into an ore car on a lower level, which runs by tramway over platform scales, and thence by platform elevator to the crusher floor, where it is dumped and the contents are shoveled into a crusher of large capacity. The crusher discharges directly into the large sampling machine, of which we show an illustration. In passing through this machine the fall of the ore is partially intercepted by three revolving apportioners. The uppermost of them separates two parts of from one-half to one-eighth of the whole lot, according as it is adjusted. These parts are successively quartered by each of the lower apportioners, a division clearly accomplished at a desirable low speed by giving each of the lower apportioners three times the revolutions of the one above it, and causing the middle apportioner to revolve in the reverse direction, which is equivalent to quadrupling the revolutions of each successive apportioner.

The bulk of the material as "discard" is then automatically received into an elevator, lifted, passed through crushing rollers and screens, and finally delivered to bins ready for roasting, while duplicate samples are delivered from the sampling machines for assaying. This whole work from the railroad car to the bins costs only 24 cents

a ton, and that at a liberal rate of wages, and including the services of a foreman and weigher. The cost of the sampling proper is less than 3 cents a ton.

The sampling begins almost simultaneously with the unloading of the car, and is finished, the machine cleaned (occupying about fifteen minutes), and the samples delivered to the assayer within half an hour after the completion of the unloading. Forty thousand pounds per hour of material crushed to about three-fourths inch to 1 inch size, is found to be within the capacity of the machine.

The space required for sampling at these works is only 10 feet by 20 feet, and at the works of the Cia Metalurgica Mexicana the use of one of these very compact and effective sampling plants enabled the management to strike a 60-foot by 100-foot building from their plans.

The sampling is found to be accurate when tested by the most careful hand sampling, and with the check of duplication; and this, with the freedom from the possibility of hand tampering, leaves little to be desired. Even if the feeding is irregular, the samples are so made up that very trustworthy results of the average character of the ore are secured.

Those portions of the material which are finally delivered as finished samples must have passed through the machine without having been touched by it to any appreciable extent, thus making it impossible for any segregation of "coarse" and "fine" to occur. The material in the sample buckets is necessarily of the same constitution as when it left the feed spout. The machine samples either fast or slow, and treats equally well all the different materials, from flue dust to granulated copper carrying 1,000 ounces of silver to the ton.

Following is a characteristic test. In the table A and B are the results of assays of machine samples of a load of copper matte (weight 47,791 pounds, car No. 5416) samples weighing from 600 to 664 pounds. C is their average. E and F are the results of duplicate hand samples carefully cut out from the "discard" of the machine, the samples being originally 4,800 pounds each, and cut down in two and one-half hours by two men to approximate sixteenths, weighing from 329 to 352 pounds. G is their average:

	Oz. Au.	Oz. Ag.	Pounds Cu.
A	0.25	69.6	62.4
B	.25	69.9	62.3
C	.25	69.7	62.35
E	.25	68.7	62.4
F	.25	68.9	62.4
G	.25	68.8	62.4

The value contents of this and one other car (No. 5385), which were sampled together by the shipper, are shown in H. By machine sampling the value contents were found to be as in K.

	Oz. Au.	Oz. Ag.	Pounds Cu.
H	9.439	3,289.46	58,852
K	11.799	3,296.31	58,875

The best results for very rich ores may be obtained by so adjusting the upper apportioner as to take out larger first samples; if desired, dividing the whole lot into two parts by the first apportioner and passing the large samples from the first machine through a second machine. For such secondary sampling a smaller machine is especially designed, not producing duplicates, and this should be a part of the regular sampling system for rich ores. There is thus a great convenience of close results

readily obtainable, and checked by a system of double sampling, which may be compared with double-entry bookkeeping; and there is also a very great saving in labor and building space, which makes the use of these machines a valuable economy, where clumsier and less reliable apparatus are comparatively extravagant at any or even at no first cost.

The award received by the Bridgman sampling machine reads simply:

It is strong, well built, occupies but little space, and gives a perfect average sample of the ore treatment.

The same year Mr. Bridgman received for this invention the medal and award of the Franklin Institute.

BRIDGMAN SAMPLING MACHINES.

Allusion to these has already been made. The Bridgman machine is claimed to afford a method of sampling far in advance of any other, either by hand or by machine. Following are the principal advantages: (1) It gives entirely independent double (duplicate) samples on every lot of material, affording the best possible control of results and rendering "salting" impossible; (2) it gives three or more cuts (quarterings) on each sample during a single passage of the material, thus yielding practically finished samples in one operation; (3) it is the only machine that does these things, and both points are broadly covered by United States and foreign patents; (4) it samples according to the only correct principle of taking the entire stream of material for certain predetermined periods of time, and does not attempt to take a portion of the stream for the whole time; (5) it is entirely self-contained and very compact; (6) it takes its feed directly from the crusher, and gives good results, equal to the best hand sampling, under any ordinary working conditions; (7) it requires not more than the power of one man to run it; (8) it requires no lubrication, except at long intervals; (9) it requires a minimum of repairs; (10) it will sample any material that can be crushed, even up to 10 per cent or more of moisture; (11) it can be thoroughly cleaned by one man in fifteen minutes; (12) it may be fully inspected during operation, without the necessity for the near approach of any person (this will avoid suspicion of unfairness, by enabling those who desire to watch the work); (13) it requires not over one-tenth the space that hand sampling does; (14) it reduces the cost of sampling to one-tenth that of hand work, and does not, like present methods, require the use of the best judgment and the greatest vigilance, but rather a mere faithful performance of routine; (15) it is free from all personal influence and entirely impartial, thus avoiding disputes; (16) it gives final samples so quickly that all lots may be sampled and disposed of as soon as received (this quickness makes it furthermore possible to use the machine samples for moisture determinations, as well as for the metals, thus saving work and getting fairer assays); (17) it is adjusta-

ble and gives larger or smaller final samples, as may be required by the different grades and kinds of material.

RETORT AND BULLION FURNACE.

Having briefly described the machinery used in ore treatment from the crushing to the amalgamation and smelting, we recur to the retorting or treatment of the amalgam scraped from the plates or collected, as may be, in the amalgam traps or wells connected with mills and

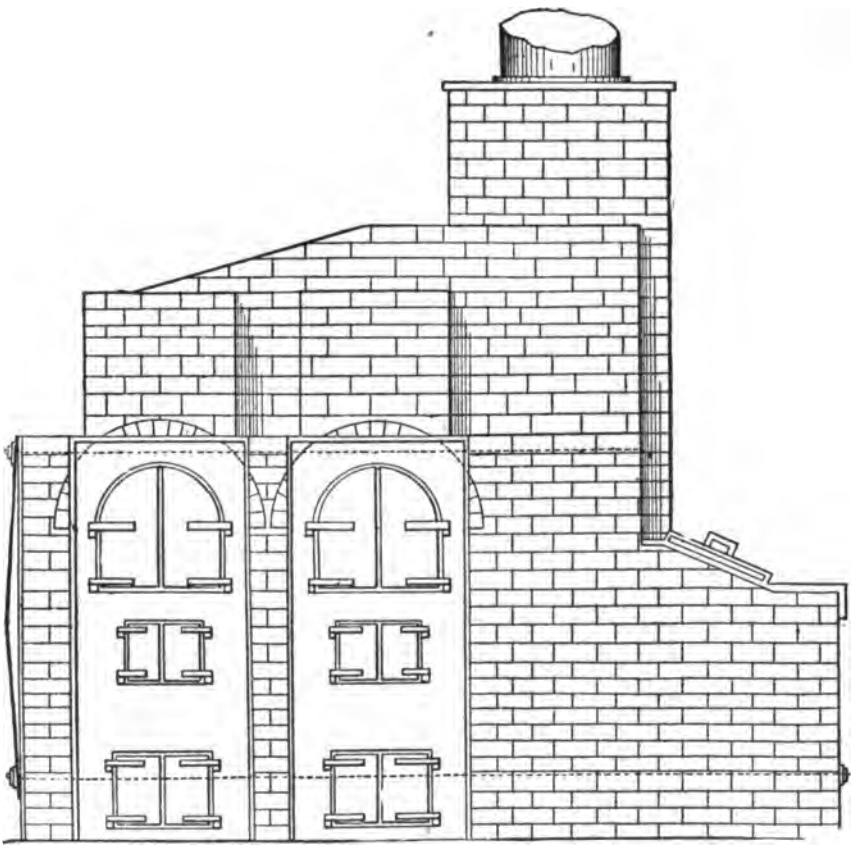


FIG. 1.

vanners. This amalgam is mercury which has taken to itself the precious metals, and it is simply dissociated by use of a small furnace plant in which the mercury is vaporized and passes to a condenser, while the bullion remaining is left, melted, and run into small molds, forming ingots in merchantable form. This bullion is not of uniform quality, but subject to further processes of refinement, separation of gold from silver, and elimination of the small percentage of impurities. These are too technical to be enlarged upon here. They belong to mint and laboratory practice, while the work of the mill ends with retorting, in which the values are obtained in a very compact form.

We quote a brief statement of the ordinary process of retorting, using what is called a pot retort, also the text of award to Fraser & Chalmers for their exhibit of an improved type of retort and bullion furnace, the merits of which are explained in the award.

Retorting.—After the amalgam has been carefully cleaned and squeezed until it is quite hard, take what is known as a pot retort and chalk it inside so as to fill up all imperfections in the casting, and prevent the retort from sticking to the pot. Place the amalgam in it as squeezed, making it highest in the center, so that it will make a nice retort, and when it settles will not go down too much in the center. Build a small fire around the retort until the quicksilver starts to come out of the condenser, always placing a kettle or pan in the tub, into which the pipe leads to catch the quicksilver,

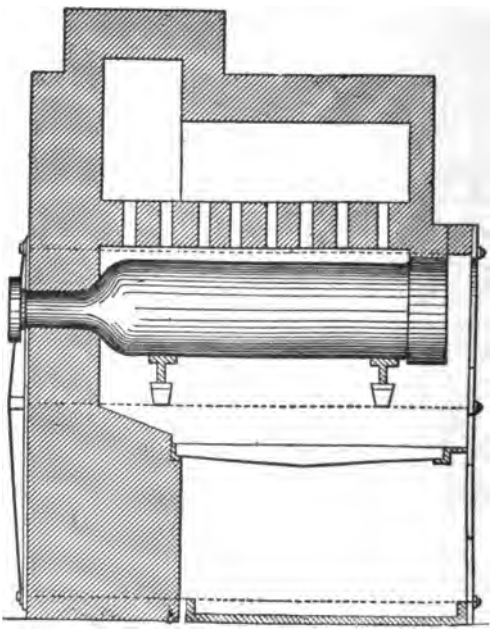


FIG. 2.

and when it has stopped coming out of the condenser and is retorted sufficiently, build a hotter fire under it to make the retort hard and solid. Before placing the cover on the retort, be sure that the condenser pipe is perfectly clean, and after the quicksilver has started to flow see that the condenser pipe is kept clear and that the quicksilver is not allowed to stop running until it has all come out. Otherwise, should the quicksilver get stopped in the pipe there is always the possibility of an explosion, which is liable to happen once in a while through carelessness.

HOISTING MACHINERY.

The single-cylinder drum hoist on exhibition was but a small sample of the machinery built by Fraser & Chalmers in this line, as they have built some of the largest hoists in operation. It was a neat design, thoroughly furnished with brakes and regulating equipment.

In case of inattention, even if the cage should be torn from its cable,

it would stop under control of the safety device, not falling more than 2 feet, as was repeatedly tried for the interest of visitors during the Exhibition.

PLATE 18.—Safety hoisting cages.

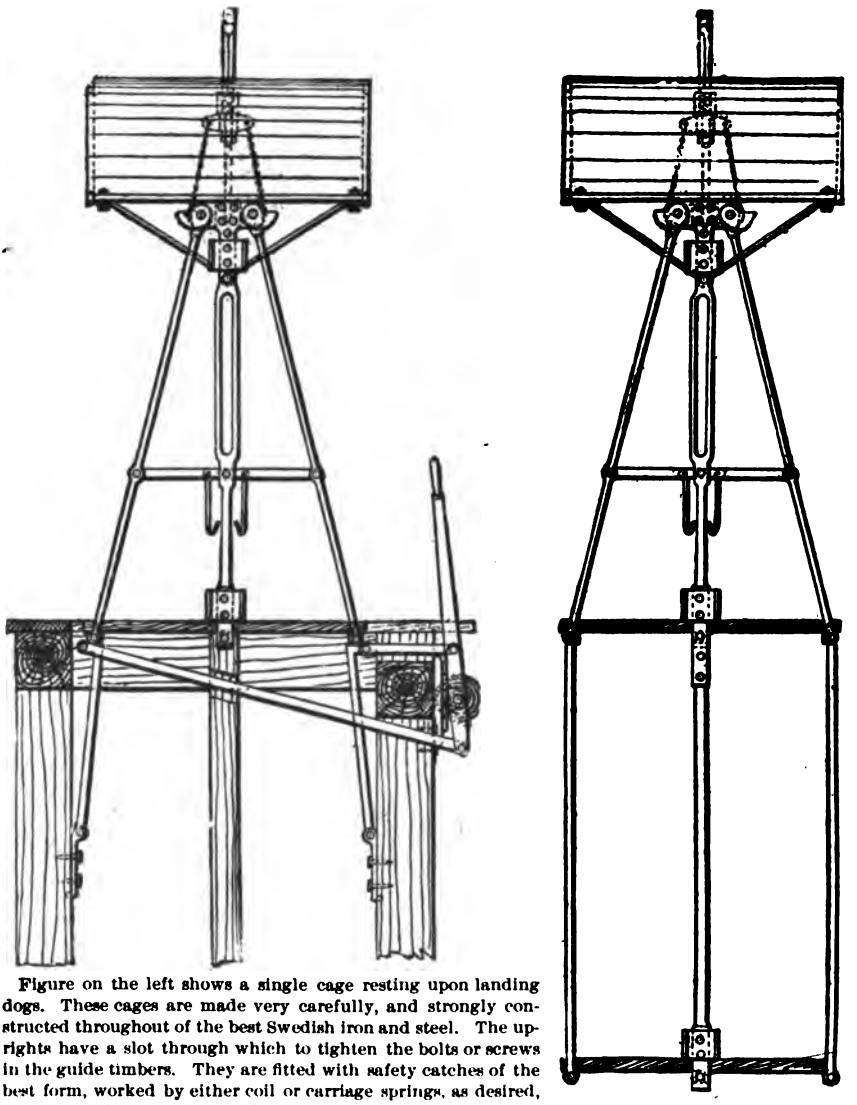


Figure on the left shows a single cage resting upon landing dogs. These cages are made very carefully, and strongly constructed throughout of the best Swedish iron and steel. The uprights have a slot through which to tighten the bolts or screws in the guide timbers. They are fitted with safety catches of the best form, worked by either coil or carriage springs, as desired, preventing the possibility of the cage falling, should the rope break. They are held away from the guides while the weight of the cage hangs on the rope, but are released and spring against the guides immediately when the strain is taken from the rope, either by its breaking or otherwise. The platform is planked over and has a track built in, so that the cars can be very quickly run off or on. All extra handling of material is avoided by loading directly into the cars at the end of the drift or tunnel, and running the same upon the cages, hoisting to surface, and while being dumped sending down an empty car upon the cage. A sheet-iron hood or shield is attached to the top to prevent the men from being injured by anything falling down the shaft, and hinged to open toward the center to admit carrying long mine timbers on end. Figure on the right shows a double-deck cage for deep mining, when hoisting capacity is still further to be increased. This cage carries two cars, reducing the number of trips, economizing in fuel and time.

RIEDLER PUMPING ENGINES AND AIR COMPRESSORS.

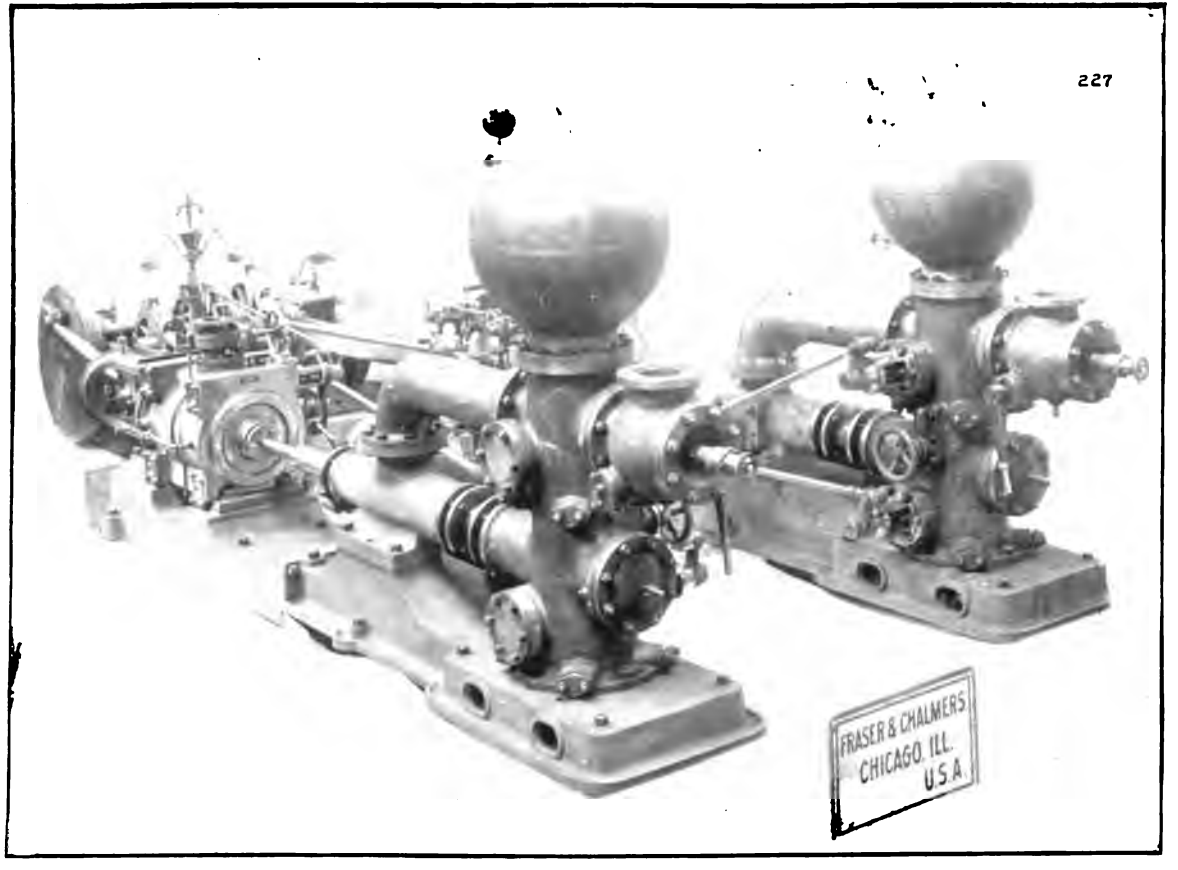
The Riedler system, applied both to water pumping and the compression of air and gas, was illustrated by a beautiful exhibit of a duplex differential Riedler pump, plungers 5 inch and 7 inch by 30 inch stroke, actuated by a horizontal cross-compound condensing Corliss engine, cylinders 12 inch and 18 inch by 30 inch stroke; capacity 900 gallons per minute against 300-foot head at 90 revolutions. This was designed for a deep-mine pump, similar pumps being built for 2,000 feet on any practicable head. The diagrams of pump action showed a perfect rectangle which signifies perfect action. The large positive-closed valves in place of the numerous water-closed valves commonly used give this pump a capacity due speed about three times what is practicable with an ordinary pump. The system was designed and patented by Prof. A. Riedler, of Berlin, after a scientific study with the engine indicator in which hundreds of pumps of every type were examined and their internal action analyzed. It is not, therefore, a chance invention, but an invention more meritorious and more satisfactory to scientific men, because it is founded upon patient and thoughtful scientific research.

It should be remarked that the hoisting shaft at the exhibit connected with a tunnel and was used for the transfer of diamondiferous blue earth, which was crushed by the Blake crusher and treated in the exhibit of the De Beers mines, managed by Tiffany & Co., New York. For these great mines Fraser & Chalmers have furnished some of the most economical and smooth-running triple-expansion Corliss engines that have ever been built, which brings us to the award received on Corliss engines:

[United States. Department F, machinery. Exhibitor, Fraser & Chalmers, address, Chicago, Ill. Group 69, class 415. Exhibit, triple-expansion condensing Corliss engine.]

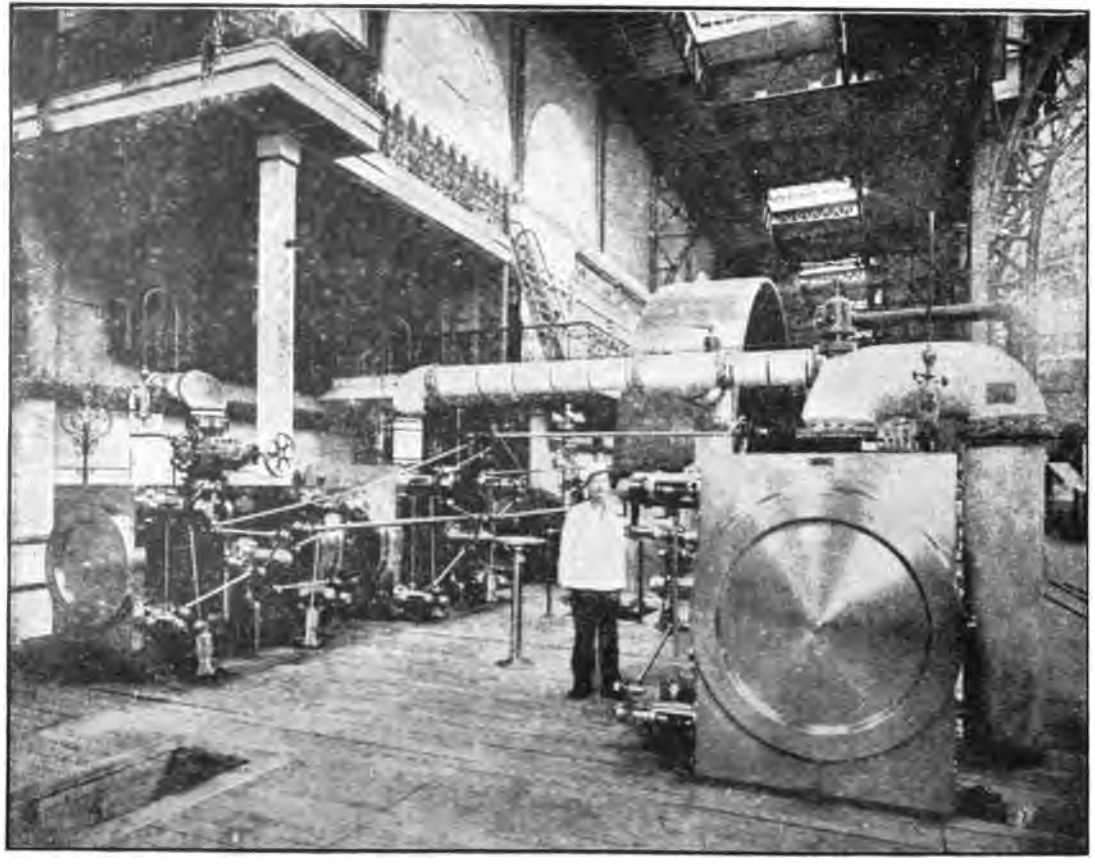
AWARD.

Triple-expansion Corliss engine of 1,000-horsepower, furnishing power to one of the large dynamos at Exhibition. This engine has four cylinders, two on each side, arranged tandem, three of the cylinders, viz, the two low-pressure and the intermediate, being of the same size and cast from the same pattern. The diameters of the various cylinders are respectively 20 inches and 34 inches, and the approximate ratio of volume 1, 2.27, and 4.53. Cylinders and heads are all steam-jacketed, the method of jacketing the cylinders being by the use of liners, packed at each end with a copper ring. The engine is strong and heavy. There are some novel and advantageous features possessed by the engine in matter of detail. The valve-operating mechanism is arranged with releasing gears and dashpots placed inside the valve links out of the way, the dashpot being offset and inclined from a vertical position to clear the exhaust-valve bonnets. The governor is of the high-speed Porter type, having inverted pendulums. Ordinarily the cut-off mechanism operates solely on the high-pressure cylinder. When, however, a sudden change of load occurs an ingenious device comes into play which operates momentarily on the cut-off of the remaining cylinders. This action is accomplished by interposing a dashpot and a double-acting spring between the governor rod and the releasing gear of the cylinders.

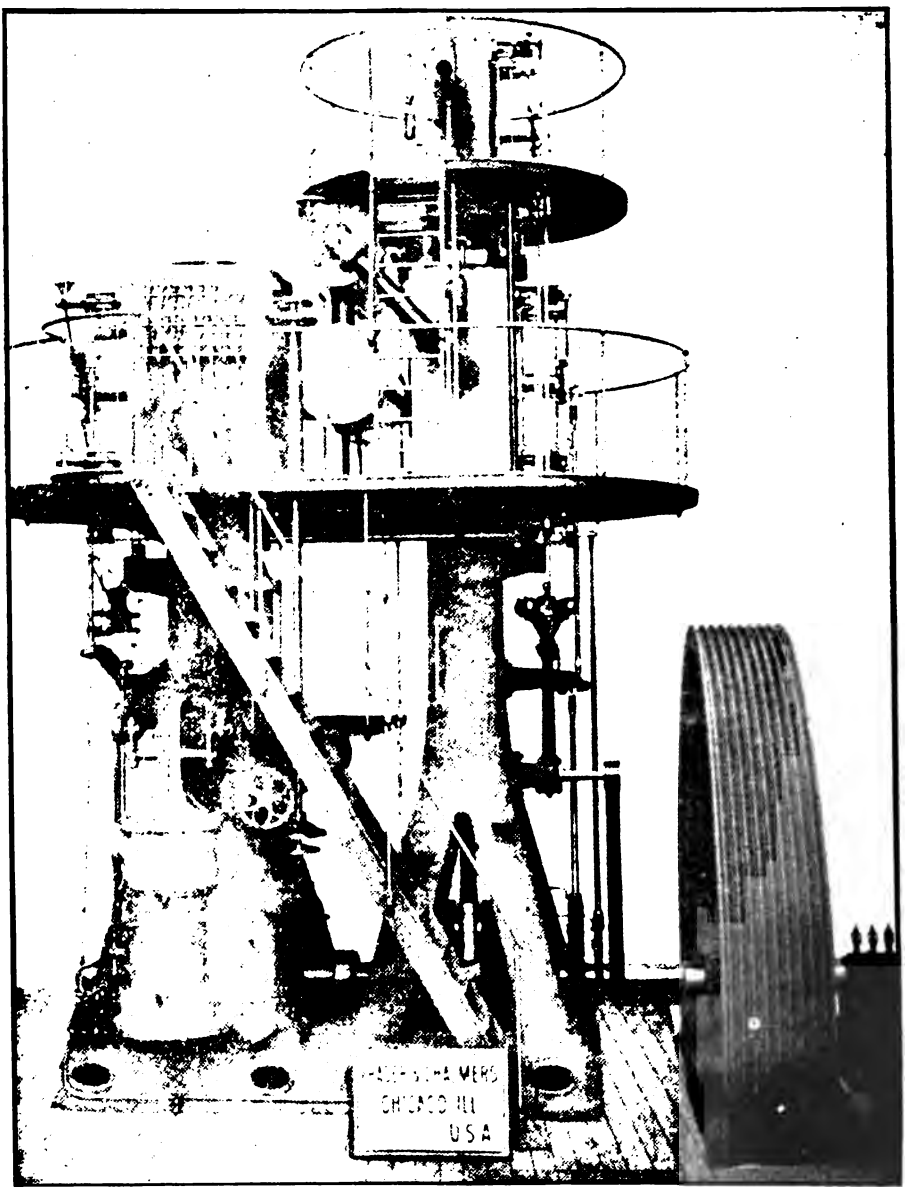


RIEDLER PUMPING ENGINE AND AIR COMPRESSOR.

Main



ENGINE BUILT BY FRASER & CHALMERS, CHICAGO, ILL.



VERTICAL TRIPLE-EXPANSION CORLISS ENGINE.

U of M

Superiority in the general design of the engine and improvements in details of construction, especially in the governing mechanism.

GEO. H. BARRUS,
Individual Judge.

Approved: JOHN A. ROCHE,
President Departmental Committee.

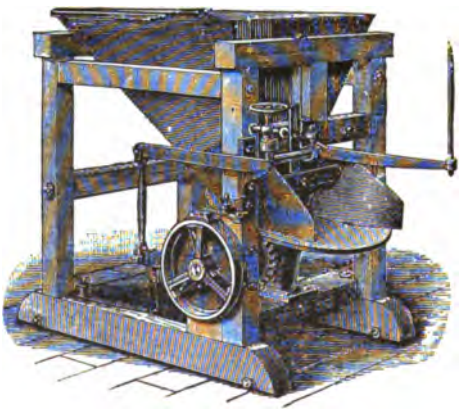
Approved: JOHN BOYD THACHER,
Chairman Executive Committee on Awards.

The Corliss engine shown by Fraser & Chalmers at the World's Fair was of a different arrangement from the four Corliss engines furnished to the De Beers Diamond Mines, South Africa, but all were designed by the same skilled engineers, and of the same high order of merit.

The exhibit of Fraser & Chalmers had a wider range than that of merely ore reduction. It applied also to hoisting, pumping, conveying, and the supply of steam power. A general award was received.

THE CHALLENGE ORE FEEDER.

The exhibit of the Joshua Hendy Machine Works, of San Francisco, Cal., contained, in addition to the hydraulic giants and hydraulic elevators described under the head of group 59, placer, hydraulic, and drift mining, the important adjunct of all quartz or stamp mills, an automatic ore feeder. The form manufactured by these works is known as the "Hendy Challenge ore feeder."



Hendy Challenge ore feeder.

In the process of milling metal-bearing ores, one of the most important elements contributing to the proper disintegration of the ores under the action of the stamps and insuring the closest approximation to a complete amalgamation of the valuable metallic particles contained within the ores is the proper automatic feeding of the ores to the stamps, and to accomplish this self or automatic ore feeders are now fitted in every well-appointed quartz mill.

In order to reduce ore properly by the battery process, the theory of feeding must be understood. It is strange that intelligent mill men should so often disagree on this important point. The theory is simple, and a simple, practical illustration will prove it to be so. Take an ordinary hand mortar and pestle and attempt to pulverize a quantity of quartz; drop in but a small quantity—just sufficient to cover in a thin layer the bottom of the mortar—and it will rapidly pulverize under

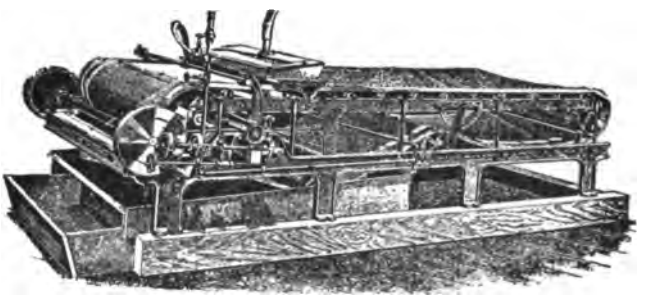
the blows of the pestle; drop in a large quantity and the blows of the pestle will be ineffective, and time and labor will be lost in the effort to reduce it to powder. Therefore, let this rule be observed, to so adjust the rod leading to the lever bar of the ore feeder that the stroke of the tappet shall cause it to "feed low," and then the desideratum of the "largest quantity of ore milled in the shortest period of time" will be attained. Certain improvements have, however, been introduced into the construction of the Challenge feeder. The rock shaft in front receives the blow of the tappet through the bumper rod from the middle stamp of a five-stamp battery, and this obviates the necessity of building right and left hand feeders as heretofore, and consequently the necessity of ordering right or left hand feeders or their parts whenever the latter are required, except by those persons who are using the old style. A further improvement will be found in this: That the lever attached to the friction grip is placed outside of the frame and the friction brake is now fitted on top of the brake wheel, and not underneath, as formerly, being thereby relieved from the grinding action of sand, etc. It has been satisfactorily demonstrated that this change of mechanism permits of greater ease of adjustment in the operation of these feeders.

The inventors state that more than 5,000 have been placed in successful operation; that the principle upon which a thoroughly practical ore feeder must be constructed is that of a carrier and not that of a percussion shake nor roller motion. Uniform and accurate feeding is not possible with either of these two latter movements. The ore must be evenly carried, upon a steadily advancing plane or table, to the line of discharge into the mortar, and then simply dropped. Jerky or spasmodic contrivances will not answer the purpose for wet, sticky ores.

IMPROVED TRIUMPH ORE CONCENTRATORS.

The mechanical concentration of ores is based entirely on the differences of the specific gravity of their component parts, and one of the most important points to be considered and accomplished in the treatment of gold-bearing ores is "the nearest approach to a separation of the siliceous and gangue matter from the residue mineralogical contents of the ores," whatever difference of specific gravity may exist. Many devices have been conceived, invented, and introduced to the notice of mining men for the purpose of effecting the proper separation of the pyritous matter contained within the ores from the accompanying gangue, and among them was that which we have designated as the "Triumph" concentrator, a brief description of which we herewith append. They are constructed in the best manner; their frames being of iron, insures their solidity, durability, and perfect steadiness of motion when operated. They are built as compactly as their requi-

site strength will permit, weigh less, require less freight spaces in boxes (by which their cost of transportation is reduced), and occupy less mill room when set up. The endless belt is carried upon a supplementary frame, which is mounted upon springs. The reciprocating movement which is imparted to this supplementary frame and belt tends to settle and retain the sulphurets and heavy and valuable metallic particles upon the belt until they are discharged at the proper moment. This peculiar movement is of the utmost importance, and enables these machines to perform a large amount of work. The rolls supporting the belt are of galvanized metal, which will neither warp, crack, nor rust. The feeding mechanism is perfect, and permits the travel of the belt to be varied at will to any desired speed. The belts are of an improved form and manufactured of rubber for this special purpose, and are very durable. Certain improvements have recently been introduced, and certain advantages thereby gained. These advantages are obtained by reason of the fact that the crank shaft is



Improved form Triumph ore concentrator.

now placed and fitted at the head of the concentrator, clear of the belt, and in direct view of the operator or attendant. This, of course, greatly facilities the oiling of the bearings of the shaft and connecting rod, and precludes the possibility of any sand or detritus passing over the belt from reaching or getting into the bearings.

The forms of the bearings, and as well of the connecting-rod brasses, have also been very much improved, making them stronger, simpler, and more easy of adjustment. Important changes have also been made in the feed screw and quadrant for regulating the belt, with the view of making all parts of the machine stronger, more accessible, and as easy of regulation as possible.

These concentrators are built either 4 or 5 feet wide, and are furnished with either plain or riffled surfaced belts, as may be ordered and deemed appropriate for the conditions of use. Weight of machine (boxed), 2,270 pounds; weight of belt (included in above), 220 pounds; weight of heaviest part of machine, 80 pounds.

For uniform and close concentration the speed of the driving pulley of each machine should be adjusted and maintained at 230 revolutions

per minute, or as nearly as possible. The size of driving pulley is 10 inches diameter and 3 inches face, tight and loose. The power required for driving each machine has been carefully determined by an indicator to be less than one-half of 1 horsepower.

Extraction of Gold and Silver by Lixiviation.

RUSSELL PROCESS.

This process, devised by J. R. Russell, of New Haven, Conn., was the subject of a very complete exhibit by the Russell Process Company, of Park City, Utah. This exhibit consisted of a model of a leaching plant, showing all the steps and stages of the process for the extraction of gold and silver from their ores, metallurgical products, or tailings. It is claimed for it that it metallurgically and economically occupies, first, the Kiss, Patera, or old leaching process; second, amalgamation; third, smelting of dry ores. It was at that time in use on ores at Yedras, Sinaloa, Mexico; Park City, Utah; Aspen, Colo., and on tailings at Butte, Mont.

The exhibit included: (1) Model (one-twentieth full size) of the Ontario Lixiviation plant for treatment Ontario Amalgamation tailings; (2) working model (one-tenth full size), and serving to illustrate the lixiviating, precipitation of the metals, carbonates, and sulphides separately, stirring of solutions by compressed air, settling of precipitate, decanting of the clear solutions, the handling of the products, and the return of the regenerated solution to the storage tank by compressed air (the arrangement to show this was by semicircular wooden tanks with glass side); (3) section of a full-size 17-foot ore vat, showing the method of construction, the arrangement of filter bottom, and draw-off pipe, and the mode of fixing filter; (4) filter press complete; (5) two complete sets of samples, ores, chemicals, solutions, and products; (6) charts of the Russell process, general metallurgical chart, detail lixiviation, practice chart giving quantities, strength, and sequence of solutions as applied in various plants; (7) working drawings, Aspen Lixiviation plant, Ontario Lixiviation plant; (8) photographs, interior and exterior views of Marsac Lixiviation plant, Yedras Lixiviation plant, Blue Bird Lixiviation plant, Aspen Lixiviation plant.

The following description of the process, and its practical operation, is substantially as supplied by the company.

The samples received each day at the assay office and the method of sampling are as follows:

1. Sample of raw ore from near top of furnace containing salt.—This sample serves both for the determination of the value of the raw ore and also for the per cent of salt which has been used during twenty-four hours. The sample is taken once every hour by the furnace man, the whole making one sample for each day.

A LEACHING PLANT.

2. Sample of roasted ore.—This is taken from the pile on the cooling floor, after "wetting down," by means of a long butter tryer. It is taken after "wetting down," as a better sample can then be obtained. The assay office results on Marsac ore after wetting down are the same as before, although on some other ores the difference would be several per cent, some silver compounds being probably reduced to the metallic state by contact of steam with red-hot ore. The roasted-ore sample corresponds to one vat charge of 72 tons, and therefore amounts to practically one sample per day.

3. Tailing samples.—These are four in number for each vat charge treated, and are taken as follows: When the leading and final washing of a charge is finished the sluice gate near the bottom on the side of the vat is opened and a ditch sluiced across the center of the charge from top to bottom. There are then two faces of tailings extending the whole width and depth of the charge. One sample of tailings is then taken from the top part of one face across the charge, and another from the bottom foot, and another over the whole of the two faces. The per cent apparent extraction in the mill is calculated from the value of the latter, which is the average of the whole charge. The reason for taking the other two samples will be explained later on. The above raw and roasted ore and tailing samples (6) are all the regular samples (6) received each day.

Products.—About once each ten days there is also a lot of "regular sulphides" to be assayed, and once every month a lot of "base precipitate" and a lot of "lead precipitate." After they are pressed and dried each of these products is sampled as follows: For each bucket of sulphides put into the grinder three small samples are taken as it comes out in the finely pulverized condition. These are then mixed together and quartered down. A check sample is also taken out of each sack of sulphides by means of a butter trier and quartered down in the same way. In addition to these samples of the products, there is also once every five days two samples of precipitated first wash water taken, as follows, before allowing the water to run to waste: Each sample corresponds to the contents of about twenty precipitating vats. After each vat of first-wash water has been precipitated and allowed to settle, a sample of 300 cubic centimeters is taken from the top of the liquid and placed in a bottle. The swinging discharge pipe is then lowered as near as possible to the precipitate in the bottom of the vats, and another sample of 300 cubic centimeters is taken and put in another bottle. The reason for taking these two samples will appear later on.

The samples of raw and roasted ore and tailings as they are received at the assay office, having already once been crushed by stamps in the mill through a 20-mesh screen, which corresponds in average fineness of the resulting material to crushing in a hand mortar through a

60-mesh, are merely passed through a 30-mesh in the assay office. In the case of the roasted ore, any crushing done in the assay office must not be in a metal mortar, on account of the action of the metal on the fresh chloride of silver in the roasted ore, which would cause a less percentage extraction of the leaching test.

As the raw ore naturally contains nothing soluble in water, the per cent of salt used can be determined by leaching a sample of the raw ore containing the salt with water. The value of the raw ore without salt can then also be calculated. Also in order to determine the percentage apparent extraction the soluble salts in the roasted ore must also be determined. Both these solubility tests are made as follows: Ten grams of ore is weighed into a beaker and 250 to 300 cubic centimeters of hot water added, and the whole stirred. The residue is then filtered off, washed, dried, the filter burned, and the residue weighed. The difference between this and the original weight gives the per cent of salt in the raw ore and of soluble salts in the roasted ore. The value of the raw ore without salt or of the roasted ore without soluble salts is determined by dividing the assay value of each by 100 less the per cent of solubility.

Two leaching tests are made on each vat-charge sample, one by the ordinary and one by the extra solution. The former is made merely as a check on the furnace work. The latter is the standard for mill work in the leaching department of the mill, the aim being to obtain the highest per cent possible in the assay office by any combination of hyposulphite and bluestone and to reach that standard in millwork. In most mills using the Russell process that standard is actually reached and in some mills exceeded, the mill methods, which can not be exactly duplicated in the assay office, being on some ores more favorable to a higher extraction than the assay office. The mill work now at the Marsac is about 1¼ per cent behind the standard in the assay office. Probably this is due to wetting down the ore while red hot on the cooling floor, which, in the case of Marsac ore, while not affecting the assay office results, does probably affect those in the mill.

In making the fire assays on raw and roasted ore and tailings, one-half an assay ton is used, mixed with 50 grams of litharge and 11 grams of a flux, consisting of 70 per cent carbonate of soda, 20 per cent litharge, and 10 per cent flour. After thoroughly mixing, the whole is placed in a No. 7 French crucible with 14 grams of powered fused borax on top and a cover of salt. The fusion is made in a coke fire, and is complete in about 35 minutes. The resulting buttons weigh 10 to 15 grams.

Assaying of products.—The assay of the regular sulphides, which is the precipitate from the leaching solution and the base precipitate which is obtained from the first-wash water by scorification is as follows: One-twentieth of an assay ton is used and 50 grams of granulated lead, of which

one-third is first placed in the scorifier and hollowed out to receive the sulphides, which should not touch the scorifier anywhere. The sulphides are then placed in this cavity and covered with remaining two-thirds of the granulated lead. Finally, 6 grams of pulverized fused borax is placed on top. The sample of wash water is thoroughly shaken and a 500 cubic centimeter sample taken, heated to about 125°, to which is added sodium sulphide in slight excess. The precipitate is then filtered off, dried, the filter burned, and the residue assayed. As the wash water after precipitation in the mill, which is only a partial precipitation, still contains considerable of base compounds, the assay of the residue is made with the same flux as is used for ore, but with 10 grams of silica and a small amount of niter added. The assay of the mill-stock solution which is occasionally made is in the same way, but no niter is used.

The determination of the amount of silver entering the slags and cupels in any of the above fire assays is made as follows: Crush one cupel and corresponding slag together through a 30-mesh screen and mix with the following flux, consisting of 80 grams litharge, 8 grams of silica, 15 grams carbonate of soda; and 20 grams of a flux, consisting of 20 per cent litharge, 70 per cent carbonate of soda, and 10 per cent flour. Mix thoroughly and cover with 22 grams of pulverized fused borax and then with salt. Fuse in a crucible not smaller than No. 8 French, starting the fusion very slowly to avoid boiling over.

Marsac ore is one of only a few wasted ores which can be wet down while red-hot on the cooling-floor without much injury. Owing to its fineness and dusty nature, the small amount of sulphur contained in it, charging it to the vats dry would be inconvenient. After the ore is wet down it is shoveled into iron mining cars and transferred to the ore vats. The time of charging an ore vat is twenty to twenty-four hours.

In starting in to treat a new ore, however, it should not be wet down on the cooling-floor until good results have been obtained without wetting down. It should also be charged to the ore vats cold at first. In charging on vats with ore which has or has not been wet down, the filter should be covered with 6 to 12 inches of water before any ore is thrown in, to protect the filter in case of any hot ore still remaining. Even if the ore is thrown in dry and hot the stairs of the vats will not be injured, as they, being wet and becoming covered with a layer of wet dust, are protected from the hot ore.

A peculiarity of Marsac ore as distinguished from the majority of wasted ores is the appearance of a large amount of white precipitate in the first wash water, consisting mostly of lead sulphate, with some lime and about 4 per cent of silver as chloride. This precipitate appears in considerable quantity whenever the first wash comes hot from the ore vats; that is, if the ore is charged hot to the vats, par-

ticularly if the amount of water used is small. Nearly all this white precipitate is thrown down by dilution, and its appearance in the outlet hose of the ore vats and under the filters is apparently due to a cooling or dilution of this wash water under the filters after passing through the ore.

For the first year and a half after the introduction of lixiviation at Marsac mill, some difficulty was experienced in keeping the space under the filters and the outlet hose clear of this precipitate. During this time, in charging the ore vats only a few inches of water was run into the filter before any ore was charged to the vats; just enough to keep the filter from being charred by any lumps of hot ore which might not have been wet on the cooling-floor. As the vat was gradually filled with ore, water was introduced through the bottom of the vat and allowed to rise in the ore, so that when the charging was completed the water stood about at the surface. Water was then introduced into the surface and the downward leaching commenced. As a result the wash water ran very hot from the ore vats, and considerable white precipitate was thrown down under the filter and in the outlet hose and launders. The white precipitate was also probably deposited in the ore making the vats of leaching slower. Besides stopping up the outlet occasionally and diminishing the vats of leaching there was another disadvantage connected with this white precipitate, which will be mentioned further on.

All this difficulty connected with the formation of the white precipitate has been removed by filling the ore vat to the depth of 45 inches with water before any ore is charged to the vat. The ore is thus dumped into a large amount of cold water, care being taken to dump it evenly all over the vat, as otherwise, if dumped in one place the heavy sand would be at that part and the slimes at all the other points. As a result the amount of white precipitate formed amounts to only one-twentieth as much as before, giving no trouble. Also the rate of leaching is increased 36 per cent, being now 3 inches per hour as against 2.2 before the adoption of the above-mentioned method. In the case of a quick-leaching ore dumping into 45 inches of water would probably decrease the rate of leaching.

Owing to the clayey nature of the ore and the absence of sulphates, Marsac ore with one exception stands at the extreme, with reference to slow leaching vats, the average rate of leaching for other wasted ores being 12 inches per hour, such ores as occur in Aspen leaching 15 inches per hour. As a further result of dumping the ore with 45 inches of water, probably less silver is extracted by the first wash water, but no figures can be given on this point, as the silver in the weak solution has been precipitated along with the wash water. In all cases water is introduced (first washing from below); the charge is never put in and then water turned into the top of it. Before the charging of

the ore vat is completed the 45 inches of water has risen nearly to the top of the vat.

The advantages of large charges, that is, 75 or 100 tons, instead of 10 or 15 tons, the size generally used in the ordinary process, are as follows: Fewer lines to be drawn and less dilution of solution, less chemicals of all kinds, less labor. As to the objection that the results are not as good on the lower part of the charge the table of Marsac tailings given later on shows that the average difference between top and bottom tailings is only thirty-eight one-hundredths of an ounce.

When the loading of the 72 tons is completed, the depth of charge is about 92 inches, leaving 10 inches space on top of the ore. The 92 inches decreases to 90 after the leaching has begun. The charge is now leveled off, leaving 12 inches space for making up the extra solution in the charge.

The end of the first washing is known by the fact that no red or dark results is given by adding sodium sulphide to the first wash water, or, as at Yedras, where no salts are shown by the hydrometer to be present, but at the Marsac, as explained later on, this point is not reached. The whole amount of wash water used is 115 inches in the ore vat, and amounts to 31 cubic feet per ton of ore. This amount is sufficient to remove nearly all the base metals from the ore, the wash water still showing a slight reddish-brown precipitate at the time the washing is finished and the hyposulphate solution begins to appear. Good practice would require that at the time the washing with water is finished, that is, just before the first weak solution appears, the wash water should show no dark precipitate with sodium sulphide, or no salts of any kinds by the hydrometer, which is the method used at Yedras and Marsac.

The total time occupied from the time the vat is filled until the last part of the wash water appears below at the outlet of the vat is fifteen to eighteen hours.

The determination of the alkalinity or acidity of the first wash water needs to be determined only at starting a mill, unless there should be a change in the ore, unless it is nearly neutral like the Marsac. The litmus paper may have to be left in the wash water several minutes before a reaction is obtained.

On the reaction of the wash water is based the general method of leaching pursued. As Marsac ore is nearly neutral, being sometimes a little acid and sometimes a little alkaline, any of the methods for acid or alkaline ores give good results.

After the last part of the first wash water has sunk to the surface of the ore, solution is turned onto it and follows the wash water through the charge.

Another method might be pursued, which is to let the water drain out of the charge before any solution is turned onto it. On some

quick-leaching ores this method is the best, but it is not allowable in the case of the Marsac ore on account of its slow rate of leaching and the consequent loss of fifteen or sixteen hours of time, which would be required in draining the charge. The solution continues to follow the first wash water until 40 inches of it has sunk to the surface of the charge. It then begins to appear at the outlet of the vat in a very dilute state, the first part of the solution having become mixed with the last part of the wash water. Its appearance is known by its giving a black or brown precipitate with sodium sulphide and by the sweet taste, which is the more intense the greater the amount of silver in proportion to the hyposulphite; that is, the sweet taste is strongest when the hyposulphite in the solution, however small a quantity it may be, is saturated with silver.

After the appearance of the weak solution at the outlet of the vat, corresponding to 40 inches of solution which has sunk below the surface of the ore, it is turned into launder leading to weak-solution tanks until its strength has reached about 0.6 to 0.7 per cent in hyposulphite, supposing the strength of the stock solution running into the ore to be 2 per cent. Usually two or three determinations of the strength of the solution have to be made before the strength of 0.6 to 0.7 is arrived at. This is done by one of the men, who takes 10 cubic centimeters of the solution, adds three to five drops of starch solution and runs in a standardized iodine solution from a purrette until the blue color of iodide of starch appears. The iodine and starch solutions are prepared as described in Shlefeldt's book or Daggett's pamphlet. From experience on Marsac ore this is found to be the best strength at which to "draw the line," all liquid which has appeared before that time being thrown away after having been precipitated, and all after that time becoming stock solution after having been precipitated. From the time at which the weak solution has appeared until the line is drawn at 0.65 per cent usually about 20 inches of solution has run out, the total amount of solution which has sunk below the surface of the ore being thus 40 inches + 20 inches, or 60 inches. This number of inches is noted in order that at the drawing of the second line, after the leaching with all the solutions has been finished, the silver extracted from the ore, and the final wash used to force out the solution remaining in the tailings, this same number of inches of water may be used before the second line is drawn. The stock solution in the mill is thus kept constant in volume, gaining as much from the last wash water as it has lost in the first wash water. As a rule, the strength at the second line (that is, after using the 60 inches of second wash water) is found to be almost exactly the same—viz, 0.6 to 0.7—but it is immaterial whether the strength is so or not, the main point being to use the same number of inches as at first.

In regard to allowing the 20 inches of weak solution to run into the wash-water vats and be precipitated with it, this is bad practice

in any case, but would be still more so if the white precipitate still occurred in any quantity in the first wash water. A separate tank should be provided in every mill in which the weak solution can be precipitated by itself before being thrown away. The reasons for this are as follows: In the case of an ore producing white precipitate in the first wash water and containing chloride of silver, as it is sure to do, the precipitate is carried by the wash water to the wash water precipitating tanks. If the weak hyposulphite solution which is then turned into the same tanks is not already saturated with silver, it dissolves the chloride of silver of the white precipitate until it becomes saturated. When the silver in the mixture of wash water and weak solution is precipitated by sodium sulphide, the hyposulphite is again in condition to dissolve more silver from the white precipitate. There is danger also that the wash water may be thrown away under the impression that it contains no silver, although silver may be contained in the lower portion of it when the solution is in contact with the white precipitate. Owing to the very small amount of white precipitate now found at the Marsac, there is little danger of this, but still a bottom sample, as well as a sample from the surface, of the liquid in the precipitating vat is taken. The bottom sample is taken by lowering the swinging discharge pipe down close to the precipitate and taking a sample from the outlet while the vat is still full. Each of the samples from the surface and from the bottom are about 300 cubic centimeters, and one of each is taken from each vat of precipitated wash water before it is taken away. Each five days the contents of each bottle, which corresponds to about 20 tanks of precipitated wash water and weak solution, is assayed. The formation of the white precipitate occurs in only about one ore out of five, and its formation can be almost entirely prevented, but still the mixing of wash water and weak solution is undesirable because of the mixing of a high-grade with a low-grade percipitate, etc. Although no difficulty occurs at the Marsac on account of this white precipitate, the above space has been devoted to the subject for the benefit of those who may meet with it and experience a loss from a careless sampling of the wash water at the surface of the liquid only.

The volume of the stock solution at the Marsac is 6,500 cubic feet, which is sufficient for 75 tons of ore per day, or for keeping four of the seven ore vats supplied with solution, the other three having either first or second wash water, or in process of being charged with ore. Less stock solution would be required if the rate of leaching were faster. As the amount of hyposulphite required to keep up the strength of the solution varies as its volume, the aim is to keep the volume as small as possible. The stock solution is made up by dissolving 1½ to 2 per cent of weight of hyposulphite of soda in water, and never requires to be made up but once, the same solution being now in use at the Marsac that was first made up when the mill started. The specific gravity of

the Marsac mill solution is 6° B., which is a little greater than elsewhere. It never at Marsac increases beyond this point, owing to the dilution of the solution by the first and second wash waters. The loss of hyposulphite occurring from this and other causes is made good partly by the hyposulphite formed as a by-product in the manufacture of sodium sulphide and partly by the addition of hyposulphite of soda. For the first two years all the solutions, both stock solutions and extra solutions, have been used cold at the Marsac, the temperature being about 30° F. in winter and 60° F. in summer. Since then the temperature has been maintained at about 100° going onto the ore, which is equivalent to 80° to 90° as it runs out of the charge. In most works, however, the solutions are used cold, particularly in the case of lime ores. The strength of the stock solution at the Marsac is maintained at 2 per cent hyposulphite, while at Gedras and Sombreste it is 1.4. This strength is maintained at the Marsac merely to shorten the time of leaching, less of a strong solution being required than of a weak one, and the rate of leaching being very slow for Marsac, 3 to 4 inches per hour, as against the average rate for other ores of 12 inches.

The rate of leaching, the number of inches depth of solution measured on top of the ore, which sinks to the surface of the charge each hour, is measured on a stick divided into inches, stuck up on the surface of the charge. This rate of leaching is determined twice during the treatment of a charge of ore, once during the first washing and again while leaching with the ordinary solution. The rate of leaching being known, the solutions are then timed instead of measured directly.

As already stated, the amount of hyposulphite of soda required to maintain this strength is 1¾ pounds for first year to 2 with cold solutions, equal to a cost of 7 cents per ton of ore. The hypo added now is 7 pounds per ton, the stock being maintained at from 2 to 2.2 per cent and solution warm, going on at about 100 and out at bottom at about 80 to 85.

The amount of hyposulphite used at Tedras to maintain a strength of 1.4 per cent is eighty-two one-hundredths pound per ton. At the Ontain experimental plant, treating 2 to 3 tons per day of Ontain ore, which requires a greater consumption of hyposulphite than if a greater number of tons were being treated, the stock solution has been maintained at six-tenths of 1 per cent without the addition of any hyposulphite.

For convenience, all the hyposulphite of soda used at the Marsac is added to the stock solution at the time of making up the extra solutions. At other mills, where a weaker stock solution is used, it may be necessary to add the hypo at the time of making up the extra, as the extra solution must always be at least twice as strong in hyposulphite as in bluestone.

For instance, the stock solution at Tedras is 1.4 per cent hyposulphite and the extra solution seven-tenth of 1 per cent in bluestone, which is theoretically the correct proportion, but the eighty-two one-hundredths pound of hypo per ton is added to the extra in order to make the per cent of hyposulphite exceed slightly twice the per cent of bluestone.

The strength of the stock solution is determined once each day, as follows: A sample is taken out of each precipitating vat after precipitating, and all the samples for the day, amounting to eight or ten, put in a jug. Ten cubic centimeters of this solution, four or five drops of starch solution added, and the strength determined by a standard iodine solution, as described in Daggett's pamphlet and Stelefeldt's book. Only the strength of the stock solution can be determined in this way, as the copper of the extra solution would obscure the reaction. The strength of the extra solution does not, however, require to be determined, as it is equal to the strength of the stock solution plus whatever hypo is added to the extra.

If any acid is used to purify the solutions it should be added to the stock solution and not to the extra. But acid is not now used for the purification of the leaching solutions. For one reason, no purification of the stock solution with an acid or an acid compound would be of any use if an alkaline ore were being treated, as the stock solution can only be made slightly acid without decomposing it, and this acidity is destroyed as soon as the solution comes in contact with the surface or top part of the ore.

As described later on, when soda ash is used for precipitating lead the stock solution is usually lightly alkaline with sodium carbonate. But if it is not used the stock solution at the Marsac is acid, although before the silver is precipitated with sodium sulphide it is neutral or slightly alkaline as it runs out of the ore vats—that is, the sodium sulphide used for precipitating the metals, although intensely alkaline itself, produces an acid solution when added to a neutral or alkaline solution.

In the case of alkaline ores the only means of neutralizing the effect of the caustic lime is by the use of bluestone. The effect of the bluestone is so powerful in thus counteracting the effect of the caustic alkali that the strength of the extra solution as used on most alkaline ores is only one-tenth to one-twentieth of 1 per cent this strength of bluestone, the expenditure of 2½ to 5 pounds of bluestone being sufficient for the most alkaline ores which can occur.

Although the compound of silver formed by the action of caustic alkali on silver in solution is insoluble both in ordinary and extra, yet the presence of this per cent of bluestone, one-twentieth to one-tenth of 1 per cent, renders the caustic alkali perfectly inert as to the silver compound.

The analysis of Tedras ore, for instance, is as follows, the analysis being the average for 1889:

	Per cent.
Silicia	30.10
Lime (CaO)	24.00
Carbonic acid	22.00
Arsenic	2.0
Iron	9.8
Sulphur	12.0

The carbonate of lime amounts to 46 per cent, which, in the long roasting in the reverberating furnaces, is probably mostly converted into caustic lime. Nevertheless, the total amount of bluestone used is only 5.62 pounds per ton. The method used at Tedras is somewhat different from that used in treating most alkaline ores, the extra being used after the ordinary, and of seven-tenths of 1 per cent strength in bluestone. In spite of this it may be laid down as a general rule that for alkaline ores the ordinary should not be used first, but a cold, weak extra of one-twentieth to one-tenth per cent in bluestone. In most cases this should be preceded by an extra wash water, which consists of 10 or 15 inches of the last part of the first wash water, to which one-fourth to one-half of 1 per cent, by weight, of bluestone has been added. The cold, weak extra is followed by cold ordinary solution, and then, if necessary, by warm ordinary.

As a rule, alkaline roasted ores, no matter how much lime they contain, are easier to treat than acid roasted ores, the leading solution being used cold, of less strength, and without circulating, and consequently there is no heating and less expense for chemicals. In the case of some alkaline ores the stock solution may be used so weak that no addition of hyposulphite is necessary to maintain its strength.

The term "special extra" means really a "second-hand extra," that is, an extra which has already been used on one charge of ore, and which is then pumped into another charge to be used again. It always precedes a fresh extra which is to be used on that charge, and serves to prevent a dilution of that fresh extra by ordinary solution which it would otherwise follow, and with which it would become somewhat mixed in following it through the charge, particularly as the volume of the extra is very small in comparison with the ordinary. Also by preceding the extra with a special extra less bluestone, and consequently less caustic soda and sulphur, are used. For another reason also less caustic soda and sulphur are required if the extra is used on two charges, for the more the extra is used the more of its copper is deposited in the ore. The extra is transferred from the outlet of one charge to the surface of another in the same way that it is circulated, that is, by the siphon pump and a rubber hose. Circulation of the extra is repassing the extra continuously through the same charge by means of the Aller siphon pump or ejector. Circulation is rarely done

in the case of alkaline ores, but sometimes in the treatment of acid ores. In general, circulation should be avoided, as the solution is somewhat weakened by it and the consumption of hyposulphite is increased in order to maintain the strength of the stock solution.

The extra solution at the Marsac, and on all ores, acts not only directly on the silver and gold, dissolving compounds of these metals which are not soluble in the ordinary hyposulphite solution, but it also acts indirectly in the way of keeping the ordinary stock solution free from injurious impurities, these impurities acting on the bluestone and exhausting themselves in that way instead of on the silver compounds.

The following table gives in detail the methods of leaching applicable at the Marsac for charges of 72 tons each. Each inch in depth corresponds to 19 cubic feet of solution, the whole 200 inches of solution used amounting to 53 cubic feet per ton.

The total weight of bluestone per ton used in each of these methods is: Method 1 equals 2.35 pounds; method 2 equals 2.7 pounds; No. 3 equals 4.6 pounds; No. 4 equals 4.6 pounds; No. 5 equals 4.6 pounds. Of the five methods given below the first three are the most applicable to Marsac ore.

But as the wash water from Marsac ore is almost neutral, being sometimes a little alkaline and at others a little acid, almost any of the methods used for acid or alkaline ores will apply, and will give almost the same results, although some methods require more solution and therefore more time.

The method given for Marsac will therefore include methods used for both alkaline and acid ores. The terms "acid" and "alkaline" apply only to roasted ores.

Omitting the first wash water, they are as follows:

Method 1: Twenty inches extra wash water; 60 inches cold weak extra; 140 inches cold ordinary.

Method 2: Twenty inches extra wash water; 40 inches cold weak extra; 40 inches cold ordinary; 40 inches warm ordinary; 40 inches strong extra circulated; 40 inches warm ordinary.

Method 3: One hundred inches cold ordinary; 40 inches cold strong extra; cold ordinary.

Method 4: Thirty inches cold ordinary; 70 inches warm ordinary; 40 inches warm strong extra circulated; 60 inches warm ordinary.

Method 5: One hundred inches warm ordinary; 30 inches special extra; 40 inches warm strong extra circulated; warm ordinary.

The "strong extra" consists of the stock solution with seven-tenths of 1 per cent of bluestone. The weak extra consists of stock solution with one-tenth of 1 per cent in bluestone. The extra wash water has one-half of 1 per cent of bluestone.

The following gives the amount of bluestone added to each inch

in depth of solution on the charge for a vat 17 feet diameter: For extra wash water one-half of 1 per cent equals 6 pounds per inch; for weak extra, one-tenth of 1 per cent equals 1.19 pounds per inch; for strong extra, seven-tenths of 1 per cent equals 8.31 pounds per inch.

Methods 1 and 2 are most suitable for alkaline ores, although method 3 with the addition of allowing the extra to stand twelve hours in the ore, is the most suitable for Ledras ore, with 46 per cent cadmite of lime in the raw ore. The extra at Ledras may also be circulated either with or without standing.

Methods 4 and 5 (and also allowing the extra to stand instead of being circulated) are suitable for the most acid ore, like Sombreste, containing 66 per cent sulphates in the raw ore, the analysis of Sombreste ore being approximately as follows:

	Per cent.
FeS	40
ZnS	12
PbS	13
Insoluble	34

The strength of the extra solution at the Marsac is the 2 per cent strength of the stock solution plus the 1¾ pounds of hyposulphite per ton added to the stock solution at this time, making the strength of the stock solution 2.3 per cent in hyposulphite. The extra solutions, particularly the strong extra, must be well stirred while the bluestone is being dissolved or immediately afterwards. If an extra is well stirred it has a greenish-yellow color, but if not it looks like the ordinary stock solution, as the bluestone has all settled to the bottom next to the surface of the ore, the ordinary solution remaining on top. If the extra solutions are not well stirred, the effect of the extra would be to a great extent lost, partly because the copper would enter the ore irregularly, and partly because it would be as bluestone, and not as cuprous hyposulphite. In making up the strong extra solution, a yellow precipitate of cuprous hyposulphite may be deposited on the surface of the ore. The precipitation of this yellow compound is caused either by insufficient stirring, or else there is not twice as much hyposulphite as bluestone in the extra. If there is a little more than twice as much hyposulphite as bluestone, it will be immediately dissolved, as it is perfectly soluble in a hyposulphite solution but not in water.

At the Marsac the yellow precipitate seldom forms, and then only from insufficient stirring, as the extra is there three times as strong in hyposulphite as in bluestone, owing to the strong stock solution used to shorten the time of leaching. All extra solutions for roasted ores are made up on top of the charge of ore by putting the bluestone in the chemical box which hangs over the charge, or in a small tub resting on the ore and allowing the stock solution to run through it until it is dissolved. If 30 inches of extra is to be made up and the space on top of the charge is only 10 inches, for instance, the bluestone

is divided into three equal parts and the extra solution is made up in three lots, one after the other. Each time, as soon as one extra has reached the surface of the ore, the leaching is stopped until the next lot is ready. This is not necessary in the case of the weak extras. The ordinary solution is kept running continuously. Not only the strong extras, but also the weak, are at least 2 per cent in strength at the main, as that is the strength of the stock solution from which they are made; but for a strong extra of seven-tenths of 1 per cent in bluestone—1½ per cent in hyposulphite would give the same results—while for a weak extra of one-tenth of 1 per cent in bluestone a 1 per cent strength of hyposulphite, or even six-tenths of 1 per cent would be sufficient. For ores requiring a warm extra the charge of ore should be warmed up by preceding the extra with warm ordinary solution.

A strong extra solution after being made up should not stand on the ore without being used any longer than necessary, but in the ore or after once passing through a charge it will keep indefinitely as far as known. A strong extra should not be preceded or followed by water, owing to the small volume of the extra and the proportionately great dilution with water which would occur.

During the leaching cracks may appear in the charge, due to its settling. These should always be covered up with a hoe, particularly before the extra is used. If the extra, as at Ledras or on Sombreste, ore, is allowed to stand in the ore, the volume of extra used need not always be the volume required to saturate the whole charge at once, but a smaller volume may be allowed to stand first in the top half and then in the bottom half of the charge.

In treating alkaline ores neither the ordinary nor the extra solutions should be allowed to stand in the ore during the first part of the leaching, but the leaching should be continuous. In cases where the charge is very deep and the amount of extra used is insufficient to do perfect work if introduced on top of the ore, one-half is introduced below the filter and allowed to rise up through the lower half of the charge.

Up to the time that 60 to 70 inches of solution have passed out of the outlet of the ore vat after the first wash water, or after the drawing of the first line between wash water and solution, the solution running out of the charge has a greenish-yellow color and an intensely sweet taste due to its saturation. The extra solution also has a sweet taste, but it is metallic and easily distinguished from that due to the presence of silver.

After all the leaching solutions have been used and the last of them has sunk to the surface of the charge, the second wash water is run on, the depth being equal to the depth of solution which had sunk to the surface before drawing the first line—that is, 60 inches. When this 60 inches has sunk to the surface of the charge, the strength of

the solution coming from the ore vat will be found equal to the strength at the time the first line was drawn—that is, 0.6 to 0.7 per cent. The outlet of the vat is now plugged and the tailings are ready to be sluiced out. At Marsac we saw from 28 lines, or, say, 0.7 down to 0.2 always, and sometimes run down to .0. In case water is scarce only 20 inches of second wash water need be used, which is the amount of solution which had sunk to the surface of the charge from the time the solution first appeared, after the first wash water, up to the time the first line was drawn. But if only this 20 inches is used, the whole of it is allowed to drain out of the charge into the stock solution, the result being the same in regard to restoring the volume of stock solution as if 60 inches had been used and allowed to sink only to the surface of the charge. The method of sampling the tailings has already been described. That is, a ditch is sluiced through the center of the vat from side to side and from top to bottom. The sides remain standing perpendicular, and from these two sides three samples are taken, one across the top foot on each face, one across the bottom foot, and one over the whole of the two faces. The sluicing is then resumed.

In sampling tailings it should not be done with the trier—that is, by a long "butter sampler." While samples taken in this way are fairly reliable in the case of some ores, they are entirely misleading in the case of others. If the taking of preliminary samples is necessary, as in starting a new mill, before the proper method of leaching has been determined it should be done with a long auger. Preliminary samples are not necessary after a mill is once in running order, as the method once decided on can be relied upon to do its work thoroughly. At the Marsac the tailings are not assayed until the day after they have been sluiced out. No preliminary tailing samples have been taken for two years.

We now sluice nearly half the charge, leaving one perpendicular face from which we take top, bottom, and average, as described. It is very essential that these top and bottom samples of tailings should be taken, as well as the average, because any faults in the leaching methods or the presence of impurities in the solution are certain to affect either the top or bottom tailings. For instance, if there is anything wrong with the solution it is found by experience that the top tailings will invariably show it. If there is any impurity of such a nature as to make trouble in the solution as it goes into the charge it will act most powerfully on the top tailings, causing them to assay higher than the bottom tailings, as the force of the impurity would be expended before reaching the bottom.

Also, if the solutions were too warm, as might be the case in treating an alkaline ore, the top tailings would get the warmest solution, and the caustic alkali of the ore would thus be enabled to act more powerfully on them than on the bottom tailings, making the top assay

higher than the bottom. On the other hand, it is invariably the case that if the leaching method is wrong—that is, if the solutions are used in the wrong order or not enough of them is used—the bottom tailings will assay highest. For instance, if in treating an alkaline ore, on which a cold weak extra is generally used first, the ordinary solution is used first, it will accumulate more and more caustic alkali as it passes down through the charge, causing the bottom tailings to assay the highest. Or if too little solution is used it will become saturated with silver before reaching the bottom, so that the bottom tailings will assay higher than the top. Also, if only a limited volume of extra is to be used, the occurrence of high bottom tailings can be remedied by applying one-half of the solution below the charge and leaching upward until that portion of the extra has entered the charge. In short, it is the invariable rule that high top tailings show that the fault is with the solution—that is, that it contains an injurious impurity or that it is too warm—while high bottom tailings show that the leaching method must be changed—that is, the solutions must be put on in a different order, or stronger, or more of them, or that part of the extra should be applied to the bottom of the charge. The values of the top, bottom, and average mill tailings for ten weeks ending March 21 are as follows, each charge consisting of 72 tons averaging 92 inches deep: Top equals 2.25 ounces; bottom equals 2.63 ounces; average equals 2.49 ounces. At Sombreste the charges weighed 50 tons each and were 6 feet deep, and in sampling the tailings each foot in depth from top to bottom was sampled and assayed separately, and the average was the average of all 6 feet. The following are the average values by feet, beginning with the top foot, on all the charges of heap-roasted ore: First (top) foot equals 4.7 ounces; second foot equals 4.8 ounces; third foot equals 4.9 ounces; fourth foot equals 4.9 ounces; fifth foot equals 5.1 ounces; sixth (bottom) foot equals 5.2 ounces; average equals 4.9 ounces.

The leaching method used at Sombreste for charge of 50 tons, 72 inches deep, of heap-roasted ore was as follows, the stock solution being 1.5 per cent strong in hyposulphite and the extra 1.7 per cent in hyposulphite and 0.7 per cent bisulphide, 100 inches warm ordinary, 20 inches warm extra stands six hours in top half of charge, and then six hours in bottom of charge, equals 75 inches warm ordinary. All the solutions were used warm (about 50° C.).

In treating ore which had not been heap roasted all the solutions were used cold, and both ordinary and extra were of the same strength as just given, and the method pursued was as follows: 4 inches ordinary, 36 inches extra, stands 10 hours; 100 inches ordinary. The method used in detail at Tedras for charges of 17 tons each and 62 inches depth before leaching is as follows, all solutions being used cold and the ordinary solution being 1.4 per cent strong in hyposulphite and

the extra 1.4 strong in hyposulphite and 0.69 per cent in bluestone: 100 inches ordinary, 24 inches of extra stands twelve hours, 190 inches ordinary.

The volumes of wash waters and solutions used per ton at the Marsac are as follows: First, wash water equals 24 cubic feet; second, wash water equals 19 cubic feet; total wash water equals 43 cubic feet. The 170 inches of ordinary amounts to 45 cubic feet, and the 30 inches of extra to 8 cubic feet, making 53 cubic feet of solution altogether.

The average time of leaching at Marsac, including loading and discharging of the ore vats, is as follows: Charging ore to vats, 24 hours; first washing, 9½ hours; leaching with first and second ordinary, 61 hours; leaching with extra, 19 hours; second washing, 25 hours; discharging tailings, 1½ hours; total, 140 hours. This is for an average rate of leaching of 28 inches per hour. The time of leaching depends, of course, on the rate entirely, as the depth of solution used is always about 200 inches for Marsac ore. For a rate of leaching of 12 inches per hour, which is the average rate for most ores, the total time, instead of 140 hours, would be about 56 hours, or, exclusive of charging and discharging, 30 hours.

While an extra is being used on a charge, particularly if it is used strong and warm, a black precipitate is sometimes deposited in a thin layer on the surface of the ore. This is sulphide of copper, caused by a slight decomposition of the extra solution. But if any such precipitate is deposited from the ordinary solution it will probably be found to contain sulphide of silver. The cause of the deposition of this sediment from the ordinary solution is either that insufficient time has been allowed for the settling of the precipitated solution in the precipitating vats, or else that in drawing off the solution after precipitation it has been drawn down too low. In either case the result would be that the sulphide of silver mechanically held in the stock solution would be deposited on the surface of the ore. Provided the deposition of the sulphide of silver takes place before the extra is used no loss occurs, as the sulphide of silver is all dissolved by the extra solution. If it occurs after the extra has been used a few inches of extra may be again made up to dissolve it, or a portion of an extra which is being used on another charge may be used, or the thin layer may be scraped off of the ore before the tailings are sluiced out and transferred to a charge on which extra is being used.

The precipitants used are ammonia process or Solvay soda ash (carbonate of soda) and sodium sulphide. The soda ash is used for precipitating lead. It should never be thrown into the precipitating tanks in the solid form, as has been done in some leaching works, as a portion of it will thus be wasted, owing probably to a coating of carbonate of lead forming on the outside of particles of soda ash. Besides, soda ash does not dissolve as readily as bicarbonate of soda, and if in

large particles considerable time is required for dissolving, even in water.

For the dissolving of the soda ash, for which the stock solution is used in order not to dilute the leaching solution with an aqueous solution, the soda ash may be thrown into this tank and stock solution run in and then stirred with air, or any other convenient method of dissolving it may be used. The soda-ash solution is conveyed to near the lead-precipitating tanks in a pipe, from which it is drawn in buckets and thrown into the lead-precipitating tanks. According to the nature of the ore treated and the strength and temperature of the solution the amount of soda ash used for each precipitating tank of 500 to 600 cubic feet varies from 15 to 60 pounds.

The carbonate of soda may be used in excess without other harm than a waste, as chloride of ether, and probably other silver compounds, is just as soluble in a solution saturated with carbonate of soda as in a solution containing none. In some cases the extra solution has been known to act better if it contained a little carbonate of soda.

The objects of using soda ash are, first, the prevention of the contamination of the sulphides with lead which would be precipitated by sodium sulphide in any case, and with lime, which would be precipitated by sodium sulphide if the precipitation is closely done, as is necessary in treating most ores. Second, the precipitation of lead and lime is more economical than of sodium sulphide. If the regular sulphides are to be shipped by express, it can be readily seen that base metals like lead and lime should be kept out and shipped by themselves by freight.

In the case of some ores when close precipitation of the metals from the solutions is necessary, if the lead or lime or both are not precipitated by soda ash the amount of sodium sulphate required is twice as great as it would otherwise be. Still the amount of lime and lead which is precipitated is quite small, the total precipitate of carbonate of lime and lead never amounting in practice to more than 5 pounds per ton of ore treated, and the total cost of precipitating amounting to only 7 to 15 cents per ton of ore, no matter how much lead and lime may be in the ore. But if the ore were low grade in silver, yielding, for instance, only 1 pound of silver per ton, or 15 ounces, the presence of 4 or 5 pounds of lead compounds would make the grade of the product very low.

In practice the solubility of lime in an ore by the leaching solution is much less than in the first wash water, the total amount of caustic alkali actually dissolved by the mill solution from an alkaline ore is such as can be neutralized by 6 pounds of acid to each 600 cubic feet of solution or three-fourths pound per ton of ore treated, while the caustic alkali dissolved from the same ore by the first wash water required 2 pounds of acid per ton to neutralize it. Of course, neither the

solution nor the wash water required neutralizing, but the above was tried merely as an experiment. The effect of the presence of lime in an ore is to redeem the amount of lead dissolved by the solution one-half, so that the carbonate precipitate would be less than one-half carbonate of lead.

If the first washing is at all thorough no other metals except lead and lime will be found in the carbonate precipitate.

No compounds of zinc (Blue Bird excepted), manganese, nickel, cobalt, iron, mercury, bismuth, copper, cadmium, gold, platinum, tin, antimony, arsenic, barium, strontia, magnesium, or aluminum can be present, nor any other element, as far as known, as the only compounds of these metals which are at all soluble in a hyposulphite solution are soluble in water and would be removed in the first washing. The only compounds of lead and lime which can be dissolved from an ore by the leaching solutions are sulphate and chloride-hydrate of lead and lime, of which the hydrate of lead would not occur, and the chloride of lead also does not occur in the roasting in a Stelefeldt furnace. Of course, the carbonate precipitate after being pressed, holds, mechanically, solution containing silver. If this is not washed out either before pressing or else by forcing water through the press the carbonate precipitate will contain silver. At the Artain the carbonate precipitate assayed 100 ounces per ton if not washed, and 1½ ounces after washing. In testing the stock solution of course any alkalinity arising from the use of sodium carbonate is not taken into account. At the Marsac, the amount of hyposulphite used to keep up the strength of the stock solution is the same (1¾ pounds per ton) whether soda ash is used or not. The use of soda ash is always advantageous except when there is no lead or lime in the ore in a form soluble in the leading solutions.

In cases where close precipitation is desirable, even if no lead is present, it may be desirable to precipitate the lime of soda ash. Lead or lime should not occur in the regular sulphides in any considerable amount, if they are precipitated by soda ash. The lead carbonate produced from certain ore was pure carbonate of lead, and 1 pound soda ash precipitated 1.08 pounds metallic lead as carbonate. This was while using a 1¼ per cent hyposulphite stock solution. The amount of lead carbonate precipitated was about 5 pounds per ton. As an experiment, a 10 per cent hyposulphite stock solution was tried, the result being 30 pounds of lead carbonate per ton.

The average amount of soda ash used at a certain time was 4¼ pounds per ton, using 189 cubic feet of a 1¼ per cent stock solution on ore containing 8 to 10 per cent sulphate of lead, on charges of ore 24 inches deep. At the Marsac less lead is dissolved, partly because there is lime in the ore and partly because, the charges being deep, only 53 cubic feet of solution is used. At the time of the above experiments in certain ore there was no trace of lime in the ore.

In precipitating with soda ash the precipitate settles very quickly, so that the clear solution can be drawn off soon after the precipitation, and stirring is finished. Sometimes the solution, after precipitation, has a reddish color, which indicates that it is very closely and sometimes overprecipitated. As the clear precipitated solution is drawn off from the lead-precipitating tanks it runs to the silver-precipitating tanks, where the silver, gold, and whatever copper may be present are precipitated with sodium sulphide.

The sodium sulphide is made up as follows: A drum of caustic soda, weighing usually about 675 pounds, is broken up by means of a hammer and drill into pieces weighing 10 to 12 pounds, and is thrown into the cast-iron dissolving tank. No water is used, but steam is turned on full head, which melts and dissolves the mass in about forty minutes. The sulphur, in amount equal to two-thirds the weight of the caustic soda, is then thrown in, a shovel full at a time. If thrown in too fast the mass will boil up too much. The sulphur used may be either flour or lump sulphur. The lump sulphur dissolves readily, as the chemical action between the caustic and sulphur is very violent, and the temperature rises immediately far above the boiling point of water. The addition of sulphur requires about twenty minutes, and it must be added immediately, before the caustic soda has time to cool at all. When the mass has ceased to boil it is diluted with the hyposulphite stock solution to the extent of the volume of the sheet-iron storage tank, which is 67 cubic feet. One-third of the solution is run into this storage tank and then the sodium sulphide to which the other two-thirds of the stock solution has been added is let down into it. Solution instead of water is used for diluting the sodium sulphide, in order to avoid dilution of the leading solutions, when the sodium sulphide is added to them in the precipitating vats. The whole is then well stirred. The dilution is to prevent crystallization when cool. The total time required in making the sodium sulphide is two and a half hours. As far as observed the sodium sulphide does not decompose after being made up. The sodium sulphide is drawn off from the sheet-iron storage tanks as used by means of a 2-inch pipe running to a barrel near the precipitating tanks. From this barrel it is drawn off into a pail through an asbestus-packed valve.

The quantity of sodium sulphide is less for some tanks of solution than for others. For instance, if the first ordinary solution is running from one or more ore vats which has the greenish yellow color or sweet taste, or if a strong extra is running from a vat, more sodium sulphide is required. Usually about 2 to 5 buckets of sodium sulphide are required for each precipitating tank of 500 cubic feet of solution. After the sodium sulphide is added to the solution, it should be well stirred. If it fails to settle quickly a little more stirring will help it greatly. If the solution retains a reddish color and is not clear it is

also from lack of sufficient stirring. At the new Asper mill the stirring will be done mechanically.

Recently, at the suggestion of Mr. Stelefeldt, stirring with compressed air instead of by an oar has been adopted at the Marsac, and it is a most pronounced success. Very little air is required. Over the precipitate vats runs a 1-inch air pipe from the receiver of the air compressor which furnishes air for pumping solutions and pressing the products. On this line are three valves, one over the wash water, one over the two lead, and one over the four silver precipitating tanks. To each of these is attached a small rubber hose on the end of which is an 8-foot piece of three-quarter-inch pipe. When a vat is to be stirred the end of a pipe is put down to the bottom of the tank and just a little air is turned on. The ebullition caused by the bubbles rising to the surface is so violent that the surface of the liquid rises 6 or 7 inches. The end of the pipe is moved around the bottom of the tank among the sulphides which have settled from previous precipitations. This old precipitate then comes down with the new precipitate. As a result of the use of air in this way instead of an oar, with which very imperfect stirring was done, the time occupied is less by only about one-third of that before required, and the precipitate settles much more quickly and leaves the solution clear. The amount of air required is so little that, with the compressor stopped, one receiver 14 feet long by 4 inches diameter furnishes enough air to stir four precipitating tanks, the pressure at first having been 40 pounds per square inch. The time of settling, if the solution is stirred with an oar, as formerly, is one hour, sometimes two hours.

Warm solutions make precipitating and settling easier and more rapidly, and the precipitated solution settles more quickly. The extra solution is not precipitated by itself at the Marsac as it is at Yedras, but runs to the precipitating tanks along with the ordinary and becomes stock solution after precipitation. In precipitating solutions containing copper, silver, and lime the copper begins to be precipitated first, then the silver, and then the lime. But copper can not be precipitated without more or less silver with it. On the other hand, no lime whatever is precipitated until all the copper, gold, silver, and lead are precipitated. Consequently, if close precipitation—that is, the precipitation of everything, including lime—is not necessary in order to get a high percentage from the ore, the lime may be left in the solution. There is no danger of its accumulating to any great extent by omitting to precipitate it, as it is soluble only to a very slight degree in the solution, and therefore the solution will fail to dissolve any more of it from the ore.

In order to avoid precipitating lime with sodium sulphide if the ore contains lime, and soda ash has not been used, as soon, in the process of precipitating, as the black precipitate of copper, silver, and lead is

all down and a yellowish precipitate (usually lime) begins to form, the precipitation is stopped. There is always a little silver remaining in the solution after precipitation, but the difference is not great, whether the precipitating is close or not. The average amount of silver remaining in the stock solution is as follows: Solutions precipitated closely, 0.49 milligrams per cubic foot; solutions not precipitated closely, 0.652 milligrams per cubic foot. If warm solutions are used in leaching, it is best to precipitate closely in order to prevent injury to the pipes leading to and from the storage tanks, although this would not amount to much in any case. Underprecipitation makes the stock solution have less dissolving power on the silver in the ore, and some of the silver in the stock solution, if the ore is alkaline, may be precipitated in the ore.

Overprecipitating is known by the smell of hydrogen sulphide which rises from the surface of the precipitated solution. This does not occur until everything, including lime, has been precipitated. Overprecipitation is also known if some of the precipitated solution gives a precipitate when added, in a test tube or glass, to solution which has not been precipitated. An overprecipitated tank of solution, after standing overnight, however, may not show any overprecipitation in the morning.

At the Marsac if soda ash is used to precipitate lead and lime, the solution running from the lead-precipitating tanks to the silver-precipitating tanks is quite alkaline, instantly giving a blue color to red litmus paper. But after the precipitation of the silver and copper of sodium sulphide the solution is neutral and may be slightly acid. The sodium sulphide itself is so intensely alkaline that 3 drops added to 300 cubic centimeters of pure water gives an alkaline reaction. If soda ash is not used the solution running from the ore vats to the silver-precipitating tanks is neutral, but after the precipitation with sodium sulphide it sometimes becomes acid, so that blue litmus paper is instantly reddened by it.

After precipitating a sample of the solution is taken in a glass tumbler and tested with sodium sulphide, and also another glassful is tested with some unprecipitated solution. In many cases the solution in the glass when tested with sodium sulphide, and also in the precipitating tank when more sodium sulphide is added, will show a milky white precipitate, and it might be concluded that more sodium sulphide was required, while in reality the solution is overprecipitated, as is shown by the addition of the silver-bearing solution, which produces a precipitate. In all cases when the precipitation is close, the precipitated solution should be tested both with sodium sulphide and with silver-bearing solution. If the roasted ore contains no copper as sulphate or dichloride, and the lead and lime are precipitated by soda ash, the product is usually very high in grade. In such cases a high and lower grade of product can be obtained by precipitating the ordinary

and the extra in separate tanks, as at Tedras. Sufficient stock solution should always be kept on hand in order to keep the ore vats supplied without hurrying the precipitation and the settling of the precipitate. In drawing off the clear solution from the precipitating tanks after the precipitate has settled, the decanting pipes are let down gradually, care being taken not to let them down into the precipitate. The best way is to decant to a certain line each time the tank is emptied, and then there is no danger of decanting the sulphides into the sump. This can be regulated by means of the lever on the outside of the tank.

Sometimes a little silver sulphide is deposited on the top of a charge of ore from the stock solution. This should not be confounded with the thin layer of black precipitate of sulphide of copper which is sometimes deposited out of the extra solution when it is too hot or stands a long time. But if any black precipitate is deposited while the ordinary solution is being used it will probably be found to contain sulphide of silver. Provided this deposition takes place before the use of an extra solution, no loss is occasioned, as all the silver will be dissolved by the extra solution, but if such a deposition takes place after the use of an extra, a slight loss may be occasioned in this way. The occurrence of this silver in the stock solution and its deposition on the ore is due to imperfect settling in the precipitating tanks on account of too little stirring or not allowing sufficient time for settling, or from lowering the decanting pipe into the precipitate. Most of this silver will settle in the storage tanks, but if any is deposited on the ore it may be dissolved by a few inches of a fresh or second-hand (special) extra, or after the leaching is finished it may be scraped off and put on the surface of a charge on which an extra solution is being used.

The occurrence of this silver in the stock solution may be prevented also by passing all the solution through a closed delivery filter press. But if the stirring in the precipitating tanks is done by air or by a mechanical stirrer, the precipitate will settle so as to leave the solution perfectly clear.

The clear solution, after being decanted from the precipitating tanks, run into a sump, and from thence into 2 iron drums, each containing about 200 cubic feet of solution. First one is filled with solution and then the other, and while one is filling the contents of the other are being forced up to the storage tanks by compressed air under about 40 pounds pressure. Each one of these tanks can be forced up in about 9 minutes.

In adding sodium sulphide to the wash water the copper, silver, and gold will all be precipitated before the zinc, iron, or lime begins to be precipitated. Sodium sulphide is saved and the product is maintained at a higher grade by making use of this fact. The point at which the precipitation can be stopped without loss of silver by underprecipita-

tion, if advisable, is easily known by a little experience, owing to the lighter color of the precipitate after the copper and silver are precipitated.

The amount of silver allowed to remain unprecipitated amounts to only 150 milligrams per cubic foot, which is about 13 cents per ton of ore. This is the only loss occurring in the other leaching works except that in the tailings. The precipitation at the Marsac is now complete, the liquid being overprecipitated. Of course even this silver in the wash water could be saved, but the saving would be about counterbalanced by the extra consumption of sodium sulphide and lower grade of product.

About once every four days each of the four silver precipitating tanks is cleaned out and once every ten days or two weeks the wash-water precipitating tanks are cleaned. The sulphides from the wash-water tanks go to one sump and that from the other precipitating tanks to another. From the sumps the precipitate runs by gravity to the pressure tank. When that is full, the valve between it and the sump is shut, the air turned on, and the sulphides forced into the Johnson filter press at a pressure of 50 to 60 pounds per square inch. When taken from the press they still contain 35 to 50 per cent of moisture. The pressed sulphides are dried in a steam drier in about thirty-six hours to two days. They then contain absolutely no moisture.

After grinding in the sampling mill they are sampled and sacked in double sacks.

If the washing with first wash water is thorough and the lime and lead are precipitated by soda ash the sulphides from the leaching solution can contain nothing but gold, silver, copper, and sulphur. The precipitate from the first wash water may contain various base metals such as zinc, iron, and lead.

Before the occurrence of the white precipitate in the first wash water was obviated by the use of 45 inches of water in the ore vat before beginning to load the tank, the wash water precipitate could not be easily forced through the filter press because of the heaviness of the white precipitate.

It is sometimes necessary in the treatment of very clayey ores, particularly if they are raw, to maintain a slight vacuum under the filters in the ore vats. This may be done either by a lead-lined siphon pump or ejector, such as is made by A. Aller, 109 Liberty street, New York.

In regard to the use of these siphons for producing a vacuum the following notes are important: First, as to the size of siphon pump required. If the rate of leaching without the siphon is only 4 to 10 cubic feet per hour, a No. 0 pump should be used, costing $28 (catalogue or list says $22); if it is 10 to 20 cubic feet per hour, a No. 1 siphon pump should be used, etc. Second, the steam used must be

dry. The vats should therefore be as near the boiler as possible, all steam pipes covered, and the steam at a high pressure. Third, each siphon pump must have its suction end upward, and the hose leading from the ore vats must slant all the way down, without any sag, to the suction end, so that every particle of liquid, as soon as it enters the hose, will run into the siphon; otherwise the siphon will work intermittently, first ejecting water, then steam, etc. A neglect of any of the above precautions will result in failure, as far as maintaining a vacuum is concerned.

A vacuum may also be maintained in other ways, as, for instance, by drawing all the solution through a common hand or well pump, the suction being attached to the outlet hose of the ore vat. In such a case it is essential that the vacuum should be a steady one. To effect this a valve should be arranged between the pump and the ore vat, which will allow air to enter when this vacuum rises to a certain point.

In conducting preliminary experiments on maintaining a vacuum a U tube half filled with mercury should be connected with the space under the filter, onto the pipe or hose between the ore vat and the apparatus producing the vacuum, and the amount of vacuum obtained noted. Otherwise no real vacuum may be produced, although the vacuum apparatus may seem to be working all right, as air may enter through slight cracks in the wood of the bottom of the ore vat. The ore vats must not only be well made, but also be covered on the outside with four or five coats of thick white lead. Paint on the inside should not be used, as it is not only sucked off by the vacuum but also causes the wood to dry by preventing moisture from entering.

In treating tailings in Nevada in vats 12 feet in diameter leaching without a vacuum only one-half inch per hour, with a No. 0 siphon pump, the rate was maintained at 5 to 6 inches, with steam at about 80 pounds, and vats situated from 15 to 40 feet from boiler, one siphon being attached to each ore vat.

In case the rate of leaching without a siphon is only one-eighth or one-fourth of an inch per hour on a 10-foot vat, that amount of solution will not be sufficient to keep a siphon running steadily. In such a case a small stream of stock solution may be allowed to enter the siphon along with the solution running from the ore vat, and thus enough solution will be supplied to the siphon pump to keep it running.

During January two new tanks were added to Marsac mill for precipitating the weak solution by itself. The first to precipitate lead in and second for sulphides.

For the year 1894 the silver contents of base sulphides averaged 3,350.5 ounces in silver, and 3.084 ounces gold. Sample from base sulphide tanks, after starting the weak-solution tanks, gave only 870 ounces silver and 0.70 ounce gold. Sample from weak-solution sulphide tank gave 11,624 ounces silver and 9 ounces gold. The per-

centage of silver in base sulphides for 1894 (which included the silver in weak solutions) was 15.2 per cent of the total silver product. Russell estimates the per cent of silver in base sulphides for 1895 at at 5.2 per cent.

The carbonates in weak-solution tank carry 1.6 per cent lead, 208 ounces silver, and 0.32 ounce gold.

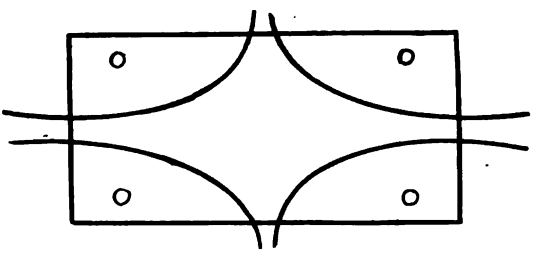
A comparison of tailings samples at Marsac mill for the three years past gives the following results:

	Ounces.
Regular top tailings	2.93
Regular bottom tailings	3.68
Regular average tailings	3.23
Tube average tailings (2 years*)	3.19
Accepted or report average	3.20

Average depth of charges, 91 inches.

These results prove that the sampling at Marsac are as near correct as it is possible to obtain.

At the Marsac mill the sump for regular sulphides is directly under the four tanks, like this, so that a portion of each tank is directly over the sump. Formerly we drew sulphide from side of tank; now we have bored a hole for 3-inch pipe in bottom of each tank about 6 inches from stave—screwing in from bottom a foot section of pipe to keep sulphides from scattering in drawing down. For plugging this hole, we use a soft-rubber plug, 4 inches, backed by wood for 26 inches, the wood being to protect the rod which holds the plug from the action of sulphides in bottom of tank. This rod is 9½ feet and extends to top of tank.



To prevent the decanting pipes from being lowered into the sulphides, rests are put on bottom of tank, so that solution is never drawn below a point 26 inches from bottom of tank. The sulphides are drawn off from each tank every fourth day, and in that time the sulphides are never up to rest. We are now using cast-iron decanting pipes, and they seem to work all right excepting the great weight, which is about 416 pounds each—probably they could be made much lighter and be just as serviceable and cheaper.

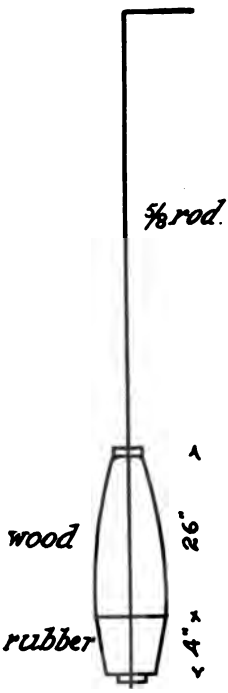
The soda-ash solution is made up in a cast-iron tank of same size as is used in making sodium sulphide—about 350 pounds being used, and dissolved in solution, steam being used for stirring and hastening the operation. After soda ash is dissolved, the solution is drawn off into wrought-iron storage tanks below (of which there are two). From

*The tube sample has only been taken for past two years.

there it is conducted by 2-inch pipe to barrel in lead precipitating room, and drawn into tanks by a short line of rubber hose, 1 inch (with asbestus-packed cocks in use wherever a valve or cock is needed).

Attached to sodium-sulphide barrel there is a 2-foot section of three-fourths inch iron pipe with asbestus-packed cock. From this the precipitant is run to the 4 silver and 2 wash-water tanks by a rubber hose. The barrel is arranged with floater and gauge, graduated to buckets, so that the right quantity can be added at first, as it gives a much clearer solution and better settling if the right quantity is run in at once.

In sampling tails, we now sluice about half the charge out, leaving one perpendicular face. Then take six samples at equal distances from each other and a foot from surface of charge; these are all put into a pan and mixed and make the top sample. The bottom is taken same way. The average sample is made up of tailings from eighteen places on face of bank—six across the top, six across the bottom, and six across the center of face.



We also take a tube sample with a 1½-inch brass tube, which consists of three cores, the first taken 9 inches from stave, the second 30 inches from stave, and third from center; these three cores are put into a large pail, water added and stirred till well mixed, and a portion taken for tube sample as a check against regular sample.

The difference on a year's samples was 0.14 ounces, the tube being the lesser value, as it requires 45 inches of water to saturate 90 inches of Marsac ore. At this time, or about five to six hours before charge is completed, the plugs in outlet hose are pulled and washing begins, water being run in on top of charge in sufficient volume so that when charge is completed the water will just cover the surface of charge after leveling down. By this method we gain this time in washing, and the water in charge is cooled gradually, which gives less of the white precipitate.

M'ARTHUR FORREST CYANIDE TREATMENT.

The Gold and Silver Extraction Mining and Milling Company of Denver exhibited the methods of extraction of gold and silver from refractory ores by means of solution of cyanide of potassium, now generally known, in brief, as the "Cyanide process."

NOM

TANK USED IN "CYANIDE PROCESS."

PLACER HYDRAULIC AND DRIFT MINING.

The Joshua Hendy Machine Works of San Francisco, S. J. Hendy, president, exhibited improved hydraulic giants and hydraulic mining gravel elevators, as also the Hendy challenge ore feeders and triumph ore concentrators.

The hydraulic giants were of the latest and most approved construction and received an award.

The efficiency of the water used in hydraulic mining depends, as is well-known, upon two chief factors—volume and pressure. Mr. Hendy states that 1,000 miners' inches of water discharged under a pressure of 300 feet, through a 6-inch nozzle, with a velocity of 140 feet per second, delivers a weight of 1,650 pounds in the same time. The cutting effect of such a mass of water in a solid column delivered at the base of a bank of gravel needs to be seen to be appreciated.

The observant, practical miners early perceived that if a given amount of gravel could be washed by the applied force of a given volume of water under a given head or pressure, that double that

Giants with plain or weighting attachment.

volume of water under the same conditions of pressure would wash from three to four times more gravel, without entailing a proportionate increase of cost of labor. Gradually, therefore, larger volumes of water and increased sizes of nozzles were introduced. Nozzles soon became the objects of inventive skill, resulting in the production of very ingenious hydraulic mining appliances. Without attempting to present illustrations or descriptions of the several forms of hydraulic nozzles or giants introduced for use in hydraulic mining in California many years ago and which have become obsolete, we simply name them here in the progressive order of their invention and operation. The first improvement was designated the "gooseneck," then followed the "Globe Monitor," then the "Dictator," then the "Hydraulic Chief," and we here present the latest form of the "Improved Hydraulic Giant" (double-jointed), for which the Hendy works were awarded the medal.

The improvements which enter into the present construction of this form of hydraulic giants relate to that class of apparatus for hydraulic mining purposes in which a jointed nozzle is used to direct a stream

of water against an auriferous gravel bank or other workings, consisting in a novel method employed in the construction of the ball, which forms the joint of the nozzle pipe. The object of this improvement is to increase the discharging capacity of the nozzle. The movement of this nozzle pipe is effected by a system of levers or a weighing attachment, and the works advocate the adoption and use of a deflector, or deflecting nozzle, to be attached to the outer or discharging end of the nozzle on the giant pipe proper, by means of which the stream of water can be directed at any angle and to any point with the utmost ease and facility.

Since the close of the United States Columbian Exposition, on October 1, 1895, Letters Patent (No. 547074) were granted by the Government of the United States to Mr. John H. Hendy, covering a further and more important improvement in the principle of operation and form of construction of this plant.

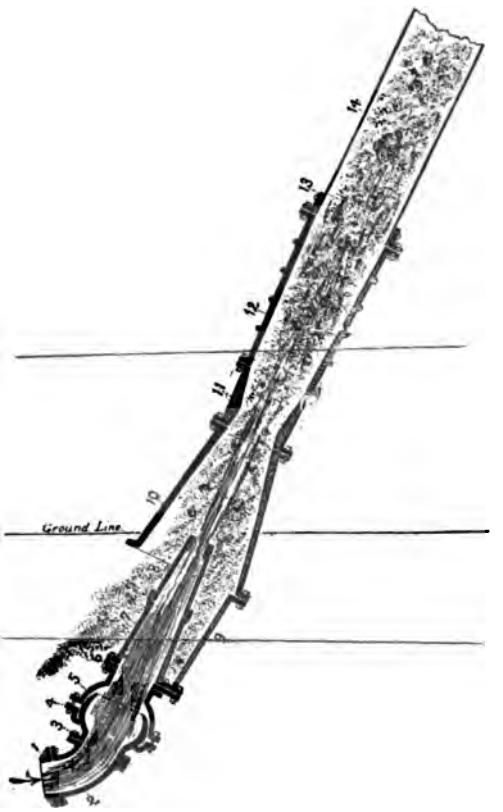
This improvement consists of a set or series of ball bearings for the rotary or swiveled parts of the apparatus, by the adjustment of which the direction of the stream of water can be easily changed, the object being to provide a bearing of little friction by means of which the adjustment of the nozzle pipe is facilitated and more readily accomplished. When an hydraulic nozzle or giant is in operation, the enormous pressure of the water passing through the elbow is exerted in an upward direction and agianst the upper bearing, upon which the nozzle is horizontally adjusted. The friction thus created in the ordinary bearings is so great that the adjustment of the giants is exceedingly difficult. The introduction of these antifrictional ball bearings entirely obviates this difficulty. These bearings are introduced into the horizontal flange bearing between the water supply pipe and the elbow which connects this supply pipe to the outer or discharge nozzle pipe, by which the horizontal direction of the nozzle pipe can be deflected or changed at will.

HYDRAULIC GRAVEL ELEVATORS.

In almost every mining district deposits of auriferous sand and gravel exist which are not available simply because no efficient system or apparatus has been devised for working them economically and profitably. Many valuable and extensive auriferous deposits are found in basins and flats, and lying along creeks, far too low to be underrun by bed-rock tunnels, open cuts, or drains, even at any cost. The only method by which they were worked was by the laborious use of shovels and wheelbarrows, whims, and derricks, and requiring in many instances the expensive maintenance and care of engines, pumps, and other machinery to free the pits or excavations from accumulating water while mining was being carried on. To overcome these expensive difficulties, and to dispense with the use of costly

pumping paraphernalia, the hydraulic gravel elevator was devised and introduced.

This elevator works upon the principle of an injector. A jet of water under pressure, as, for example, the flow from a giant, is introduced at the base of a larger tube or conduit, as shown in the sectional drawing. This conduit rests below in the bed of the creek, or low ground, from which the gravel and water are to be elevated. The violent upward flow of the column from the jet carries with it the surrounding water and gravel. The construction is simple. The conduit through which the water and gravel are raised is essentially a cylindrical iron pipe.



Hydraulic gravel elevator.

The open end of the ground section is concave in shape, or the lower half section is of heavy cast-iron pipe flaring outward, into which earth, sand, gravel, etc., are sluiced or washed by hydraulic giants through bed-rock flumes leading thereto from the auriferous bank deposit lying above, which with the elevator entrance and throat sections are set in a chamber excavated below the bed-rock surface. The bank material sluiced or washed into this entrance is taken up by the stream of water flowing from a hydraulic nozzle fixed in or near the elevator entrance pipe section, which by its impinging force impels it forward and upward through the outer discharge pipe to its point of delivery into an open flume above, whence it is carried away through a line of sluice boxes to a final dump. Confined as the material is within this tight iron pipe, it is necessarily drawn and impelled forward and upward with the velocity of the stream itself. As each particle of gravel or other material is directly acted upon by the full impinging force of the stream discharged through the fixed hydraulic nozzle, it is considerably disintegrated by such action as well

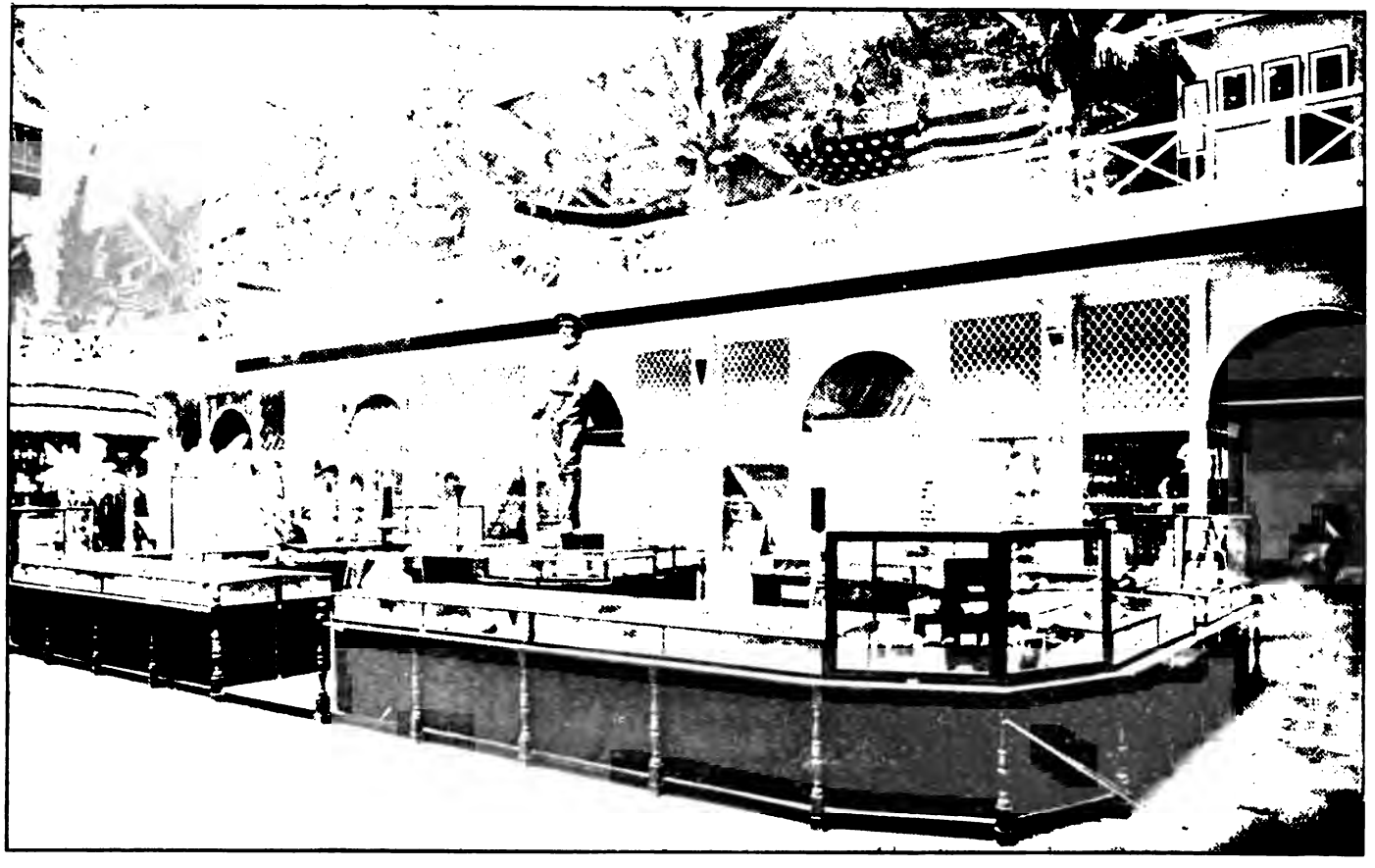
as by the friction between the fragments and along the pipe in its ascent. Pulverization is thereby rendered so complete that long or expensive outer flumes or lines of sluice boxes become unnecessary. The elevators are built of any capacity and will handle any head of water ordinarily used in hydraulic mining. As it requires no more power or force to raise 1 pound of earth or gravel than to raise 1 pound of water, the mining operations should naturally be so conducted as to endeavor to pipe as much auriferous material toward and into the elevator entrance sections as is possible, for with a proper arrangement and disposition of intervening grizzlies the elevator can seldom be overloaded.

The practical operation of these hydraulic gravel elevators has demonstrated the fact that when properly and advantageously set and operated the amount of water and material which can be raised and impelled through the upraise pipe is governed and limited solely by the volume of water used, acting under its given head or pressure, and the carrying capacity of the pipe, and it is important to bear in mind that it costs as much time, labor, and money to raise water through an elevator pipe as it does to raise auriferous earth or gravel, and it requires an equal expenditure of power or force to raise the one as the other.

The exhibitors state that it is estimated that a volume of water acting under a pressure of 100 feet (vertical) will raise material 10 feet high, and, as high pressure is more effective than low pressure, 200 feet will raise 20 feet high better than 100 feet will raise 10 feet high. Two hundred feet should, therefore, raise, say 22 feet, and 300 feet pressure, say 40 feet. These data are simply the theoretical impressions of the effective force of given volumes of water acting under given pressures, but the actual workings of these hydraulic elevators have determined a far greater effective force. In attestation of this they cite the two following instances from among many others demonstrative of the same fact, which have been verified by other users of these elevators.

At the property of the Yreka Creek Gold Mining Company, in Siskiyou County, Cal., it was found that a volume of 650 miner's inches of water under a pressure of 266 feet raised, through a No. 2 16-inch elevator, all of the material that could be continuously piped to its entrance section by a No. 3 Giant (having a 6-inch inside diameter nozzle butt) to a height of 39 feet, and could have elevated the same with equal facility to a height of 45 feet had it been required, and, as the superintendent stated to the writer, "she howled for more."

At the hydraulic mines of the North Bloomfield Gold Mining Company, in Nevada County, Cal., a volume of water representing 1,300 miner's inches, under a pressure of 530 feet, raised earth, sand, gravel,



VIEW OF THE CALIFORNIA STATE MINING EXHIBIT IN THE CALIFORNIA BUILDING. STATUE OF JAMES W. MARSHALL, THE DISCOVERER OF GOLD IN CALIFORNIA, IN THE CENTER.

etc., through a No. 3 20-inch elevator, assisted by a No. 5 Giant (8-inch nozzle butt), to an elevation of 91 feet.

The superintendents or managers of all of the many hydraulic mining properties in which these gravel elevators have been placed in operation have substantiated, over their respective signatures, the fact that the practical work of these elevators develops a far greater effective elevating power than the theoretical estimate admits.

CALIFORNIA MINING EXHIBIT IN THE CALIFORNIA STATE BUILDING.

The exhibit of the department of mines and mining of the California World's Fair commission was divided at Chicago, one part being in the State building, the other in the mines and mining building. Both exhibits compared favorably with those of other States and governments as to variety, value, and attractiveness.

More awards might possibly have been secured had all the material been installed in the mines and mining building, as the ruling of the World's Columbian Exposition excluded from competition articles contained in the State building; but the benefits derived in an advertising line from the mineral display in the California building, which brought together under one roof almost a miniature world, greatly outweighed the possible loss of some awards.

The mineral exhibit in the State building was located on the west side of the main aisle, immediately south of the San Francisco relief map, and occupied a space 50 by 30 feet, entirely inclosed by a double row of showcases filled with ores and minerals. The feature first noticeable was the large statue of James W. Marshall, the discoverer of gold in California in 1848, it being a facsimile of the one erected at Coloma, Eldorado County, over the spot where Marshall found the first nugget. At the base of this statue, and encircling it, were eight showcases filled with the richest samples of gold-bearing quartz, gold nuggets, and other valuable specimens.

One of the cases was entirely devoted to a nugget of crystallized gold, and many very rich pieces of gold-bearing quartz from the Delhi mine, Nevada County, owned by R. McMurray, a member of the California World's Fair commission. This piece of virgin gold is notable for its crystallization, forming an almost perfect representation of a fern leaf. It was one of the most attractive specimens on exhibition, and contained $140 worth of gold. Among other exhibits in a second case, especially interesting to mining men, were the numerous specimens of very rich quartz, one of which was a large piece of crystallized quartz and gold, containing about $1,200 worth of the precious metal. This was the most valuable single specimen, commercially speaking, in the exhibit, although several smaller fragments of quartz contained more gold in proportion to their size. One

piece had been sawed in too, and the flat sides polished, which greatly improved its appearance.

Two more cases were devoted to the products of the Doe & Daggett and Black Bear mines, Siskiyou County, belonging to John Daggett, now superintendent of the United States branch mint at San Francisco. Several of these specimens, besides being very rich, were noteworthy for the beautiful combinations of quartz crystals intermingled with free gold.

At the preliminary World's Fair exhibit, held in San Francisco during the months of January and February, 1893, the collection of ores from Plumas County received a gold medal for its completeness and scientific arrangement. The most valuable part of this collection occupied another of the showcases at the base of the Marshall statue. It consisted of fine and coarse gold, nuggets of various sizes, rich gold-bearing quartz, and platinum. The remainder filled the three showcases in the California exhibit in the mines and mining building.

The rest of the cases were filled with specimens loaned by the State mining bureau, county organizations, mining companies, and private individuals. As was also true of the California display in the mines and mining building, the collection furnished by the State mining bureau constituted much the larger portion of the exhibit. A total of about 1,000 specimens were exhibited in both buildings, representing every county in the State, nearly 300 of them being gold quartz.

Among objects of note in the different cases was a nugget of solid gold, weighing 30 ounces, which was found in the Blue Wing mine, Nevada County; a large number of vials containing placer gold of different degrees of fineness, principally from the Trinity River; and rare specimens of leaf, wire, and crystallized gold in quartz from the different mines in Eldorado, Butte, Tuolumne, Amador, Placer, and other counties. Among the finest of these were specimens from Nigger Hill, Jamestown, and Lovelock mines, one of these being the property of J. A. Goodwin and consisting of two almost perfect fern leaves, inclosing a quartz crystal; a splendid piece of wire gold from the Green Mountain mine, Siskiyou County; also diamonds found in different parts of the State in ancient river beds.

One object of popular interest was a gold-mounted gavel, made of manzanita, with an orange-wood handle. This gold was mined by the hydraulic process at Dutch Flat in the presence of the National Editorial Association on the 28th of May, 1892. After being melted and cast into a bar, it was presented by the California Miners' Association to the National Editorial Association as a momento of their visit to our mining regions, and was in turn made by them into this beautiful gavel.

Besides the cases forming the octagon at the foot of the statue, there were forty-eight cases, 8 feet long and 2 feet wide, and four large

corner cases, all filled with samples of ore from many of the principal mines of the State. There were also gold-bearing gravels from the North Bloomfield, Manzanita, and other gravel mines; marble from the quarries of the Inyo and Colton marble companies, and serpentine from Dr. Boyeson's quarry in Amador County, and Kimball Brothers' quarry in San Diego County. One very interesting exhibit was a pyramid of rubellite from San Diego. This is a red variety of tourmaline, which usually occurs in green and black shades.

The Mathison Smelting Company, of San Francisco, had on exhibition a remarkably fine display of antimony ores and regulus; the latter, cast into bars, showed the typical fern-leaf crystallization of pure antimony. This was considered the finest display of its kind in the Exposition.

A characteristic product of California, so immensely rich in her resources, was the onyx from San Luis Obispo County, owned by Kesseler Brothers, of San Francisco. In texture as well as in softly blended shades of color it equals if not surpasses all other kinds of onyx, even the far-famed Mexican. A beautiful assortment of this material formed part of the mineral collection in the State building, although the larger part was in the mines and mining building.

Among the economic minerals of the State the following were prominent: Aluminum ore from the San Bernardino County mine, containing nearly 43 per cent of the metal—a very high percentage; asphaltum and oil from Kern and Ventura counties; and borax from the vast deposits of Death Valley, in Inyo County.

Although nearly all counties and localities were represented in one way or another, several sent collections of their own, viz, Plumas, Fresno, Shasta, Butte, and San Bernardino counties, and thus aided materially in making the California mineral collection one of the most complete at the Exposition.

The quicksilver interest was represented by some very rich ores from New Almaden and other mines, as well as a specimen from a new mine at the intersection of McAllister and Devisadero streets, San Francisco, which was discovered while grading for building purposes.

Much interest was awakened by a meteorite from San Bernardino County, which weighed 128 pounds. In the general collection were a number of fine quartz crystals, one of which weighed 106 pounds, and a variety of petrifactions and rare minerals.

Several models of large nuggets found in California filled a corner case, surmounted by a facsimile of the largest bar ever cast, the result of one month's run in the North Bloomfield hydraulic mine, Nevada County, which weighed 6,127.78 ounces, troy, and represented a value of $114,280.72.

CALIFORNIA MINERAL EXHIBIT IN THE MINES AND MINING BUILDING.

In the mines and mining building the collection of California minerals was in many respects almost a duplicate of that in the State building, with the exception that the scientific element predominated in the former, especial attention being paid to the economic minerals.

One of the most attractive features of the exhibit was the artistic entrance or classic gateway constructed entirely of native material with a view of displaying to the best advantage the building stones of California. The façade was designed by J. C. Pelton, jr., of San Francisco. The gateway was in the form of a triple arch, with a portico in front and wings on each side. The base of the gateway, 5 inches in height, was of dark granite. The pedestals of the four columns, each 2 feet wide, were of light granite, and the columns themselves of beautiful white marble, two being from the Colton, and two from the Inyo quarries. The caps of the columns were of the Ionic order, richly carved and surmounted by a finely molded entablature. Behind the pedestals of the columns, the pilasters of the arches were formed of most beautifully veined California onyx, the arches themselves being of gray sandstone. The belt course over the arches was of Colton marble, and the panels between the belt course and the pediment were of variegated marbles, the space about the panels being of white marble. In the face of each wing was sunk a square, window-like niche, having three small Ionic columns of choicest onyx. From the floor to the top of the entablature was 20 feet, and the extreme width of the gateway 36½ feet. The wings, 12½ feet high on each side of the triple archway, were of blue greenstone, the columns flanking the windows being of onyx, and the cornice of green marble. In this way nearly all the best hard and soft stones that the State affords were shown cut, and, when feasible, polished and in actual use, as a part of the gateway. Over the central arch was the inscription, "California Mining Exhibit." The façade was surmounted by two gilded life-size grizzly bears, which attracted notice almost the moment one entered the building.

Within the classic gateway, and facing the entrance to the exhibit, there appeared large gilded cubes painted on the rear wall, serving to illustrate the comparative production of gold and other precious metals in the United States and California. The inscriptions thereon were so striking that visitors were found studying them almost every hour of the day. One inscription read: "Total production of gold in the United States since 1848, including California, $1,900,000,000. California alone during the same period, $1,310,245,000." Another gave the total production of silver and quicksilver in California since 1848 at $47,128,000 and $63,234,000, respectively, while on the three gilt cubes appeared the following: "Annual yield of gold in California at the time hydraulic mining was prohibited in 1880, 36½ tons avoirdupois, equal to $27,060,000;" "Annual yield of gold in the United

States, including California, 1892, 44¼ tons avoirdupois, valued at $32,845,000;" "Annual yield of gold in California during the year 1892, 23¼ tons avoirdupois, representing a value of $17,160,000."

The great seal of the State of California, carved in wood, was a conspicuous and very pleasing feature.

The mineral specimens, all scientifically arranged, were contained in twenty-four showcases, each 8 feet long and 2 feet wide, forming three aisles throughout the length of the inclosure. In these were displayed the finest obtainable specimens of gold and silver ores and those of other precious and economic metals, and even a few diamonds in their natural state as found in California.

CALIFORNIA STATE MINING BUREAU.

As was the case in the State building, the specimens loaned by the California State mining bureau constituted the greater portion of the exhibit. The collection by this bureau consisted of, first and principally, ores of nearly all the most useful metals, including native gold and gold quartz, accompanied in many cases with specimens of the inclosing rocks, with a view of partially illustrating their geology; second, a large number of specimens of economic value, such as borates, gypsum, sulphur, salt, clays, graphite, etc.; and third, a series of samples of building stone and marble, including the so-called "onyx." Of gold and gold quartz there were forwarded nearly 300 specimens from 25 counties; of silver ores, 85 specimens from 12 counties; of copper ores, 62 specimens from 15 counties; of quicksilver ores, 50 specimens from 10 counties; of iron ores, 35 specimens from 21 counties; of platinum, 3 specimens from 2 counties; of chrome ores, 30 specimens from 19 counties; of manganese ores, 17 specimens from 15 counties; of zinc ores, 6 specimens from 6 counties; of antimony, 11 specimens from 5 counties; of tin, 3 specimens from 1 county; of lead, 7 specimens from 6 counties. There were also a number of mineral specimens selected for their rarity or attractive appearance and a collection of the more striking and characteristic rocks of the State. Hydraulic and river mining were illustrated by a number of large photographs of actual mining scenes. In all about 1,000 specimens were exhibited, representing the mineral resources of the entire State, not a single county being omitted.

Noteworthy among other exhibits were the following: Antimony ore and regulus, by the Mathison Smelting Company, San Francisco; a collection of various minerals and ores occurring in Plumas County, by S. S. Taylor, of Quincy; rare and beautiful specimens of crystalline gold, by R. McMurray and John Daggett, of San Francisco; solar and native salts from different parts of the State, and aluminum ore from San Bernardino County, carrying as high as 43 per cent of the metal.

Of great interest was a collection of gold ores sent from Nevada County, which comprised samples from the Idaho, Maryland, and

other mines in that district. A curiosity in the general exhibit was an old-time rocker and pans, such as were used almost exclusively in the placer diggings in the early days. The pan is supposed to have been the property of James W. Marshall, the discoverer of gold in California.

List of Californian exhibitors of the precious metals.

Specimen.	Mine or locality.	County.
Actinolite		Colusa.
Alum (native)	Banner	San Diego.
Andalusite	Moores Flat	Mariposa.
Antimony, block	Boushey's mine	Kern.
Antimony (native) (2)	Hot Springs	Do.
Antimony ore	Alta mine	San Benito.
Do	Hollister	Do.
Antimony ore (stibnite)	Cambria	San Luis Obispo.
Antimony ore	Gilroy	Santa Clara.
Aragonite	Sulphur Creek	Colusa.
Aragonite (3)		San Luis Obispo.
Aragonite		Siskiyou.
Aragonite slab (5)	Suisun	Solano.
Aragonite	Vacaville	Do.
Asbestos	Red Hill	Butte.
Do	Goodyears Bar	Sierra.
Auriferous arsenical pyrite	Cloud mine	Calaveras.
Auriferous gravel	Spring Valley mine	Butte.
Do	Pioneer mine	Sierra.
Do	Bailey & Woods mine	Siskiyou.
Do	Yreka	Do.
Auriferous hematite	Rose mine	San Bernardino.
Auriferous pyrites	Golden Queen mine	Butte.
Auriferous sand	Gold Bluff	Humboldt.
Barite	Mount Diablo	Contra Costa.
Do	Callahan's ranch	Siskiyou.
Bernardinite (hydrocarbon)		Lassen.
Botryoidal calcite		
Bismutite	Deep Spring Valley	Inyo.
Boracic acid		Kern.
Borax (large refined crystal)	Harmony Company	San Bernardino.
Calcite, pink	Santa Catalina Island	Los Angeles.
Calcite, white	Santa Ana	Orange.
Caledonite	Ygnacio mine	Inyo.
Calverite telluride of gold with free gold		Tuolumne.
Chalcedony (3)		Napa.
Chalcedony	Manhattan mine	Do.
Chrysoprase		Tulare,
Cinnabar and sulphur	Sulphur Bank	Lake.
Cobalt ore	San Gabriel Cañon	Los Angeles.
Colemanite and celestite	Calico	San Bernardino.
Diatomaceous earth (electro-silicon)		
Dolomitic calcite	New Almaden mine	Santa Clara.
Epidote	Eber Flat	Tulare.
Erythrite	Compton	Los Angeles.
Feldspar, argentiferous	White Line mine	Inyo.
Fossil (jaw of horse found under 8 feet of solid lava).	Messenger Valley	Calaveras.
Fuchsite	Arch Beach	Orange.
Garnet, andradite	Tehachapi	Kern.
Gold bar model, the result of one run made in the North Bloomfield mine; weight, 6,127.78 troy; gold, 897 fine; silver, 93; total value, $114,280.72; the largest bar ever cast.	North Bloomfield mine	Nevada.
Gold in calcite	Alvord mine	San Bernardino.
Gold, placer	Spring Valley mine	Butte.
Do	Chapman & Fisher mine	Trinity.
Do	Coyle mine	Do.
Do	Evans mine	Do.
Do	Haas mine	Do.
Do	Hatchet Creek mine	Do.
Do	Hunt & Ellison mine	Do.
Do	Ward mine	Do.
Do	Nevada mine	Nevada.
Do	Campbell mine	Siskiyou.
Do	Sands of Ocean Beach	San Francisco.
Gold slug ($50) of 1851, weighs 18 grains more than $50 present United States coinage.		
Gold in hematite	Our Flag mine	Calaveras.
Gold—octahedral crystals on pyrite		
Gold in porphyry	Banghart mine	Shasta.
Gold in quartz	Altaville	Calaveras.

List of Californian exhibitors of the precious metals—Continued.

Specimen.	Mine or locality.	County.
Gold in quartz	Martin Walling mine	Mariposa.
Do	Nevada City mine	Nevada.
Gold in cinnabar, sulphur, bitumen	Manzanita mine	Colusa.
Gold in leaf form, with quartz crystals	Jamestown	Tuolumne.
Gold quartz	Bunker Hill mine	Amador.
Do	Clinton Consolidated mine	Do.
Do	Downs mine	Do.
Do	Kennedy mine	Do.
Do	North Star mine	Do.
Do	South Spring Hill mine	Do.
Gold quartz (7)	Stewart mine	Do.
Gold quartz	Zelle mine	Do.
Do	Gallagher mine	Butte.
Do	Gold Bank mine	Do.
Do	Hazard mine	Do.
Do	Adelaide mine	Calaveras.
Do	Boston mine	Do.
Do	Cave City mine	Do.
Do	Esmeralda mine	Do.
Do	Sheep Ranch mine	Do.
Do	Venus mine	Do.
Do	Clyde mine	Colusa.
Do	Manzanita mine	Do.
Do	Monticello mine	Do.
Do	Alhambra mine	Eldorado.
Do	Big Tunnel mine	Do.
Do	Cederburg mine	Do.
Do	Near Georgetown	Do.
Do	Gold Run mine	Do.
Do	Superior mine	Do.
Do	Abbey mine	Fresno.
Do	Enterprise mine	Do.
Do	Hanover mine	Do.
Do	Morrow mine	Do.
Do	Potters Ridge	Do.
Do	Railroad Flat	Do.
Do	Texas Flat mine	Do.
Gold quartz (2)	Beveridge	Inyo.
Gold quartz	Big Blue mine	Kern.
Do	Kentuck mine	Do.
Do	Evening Star mine	Lassen.
Do	Golden Belt mine	Do.
Do	Red Rover mine	Los Angeles.
Do	Josephine mine	Mariposa.
Do		Do.
Do	Tyro mine	Do.
Do	Homer mine	Mono.
Do	Mono mine	Do.
Do	Porcupine mine	Do.
Do	Standard mine	Do.
Do	Blue Bell mine	Nevada.
Do	Blue Jay mine	Do.
Do	Chicago mine	Do.
Do	Crown Point mine	Do.
Do	Eagle Bird mine	Do.
Do	Empire mine	Do.
Do	Gold Quartz Mining Co	Do.
Gold quartz (2)	Idaho mine	Do.
Gold quartz	Mayflower mine	Do.
Do	Murchie mine	Do.
Do	North Banner mine	Do.
Do	North Star mine	Do.
Do	Pittsburg mine	Do.
Gold quartz (2)	Providence mine	Do.
Gold quartz	W. Y. O. D. mine	Do.
Do	Bellevue mine	Placer.
Do	Belvoir mine	Do.
Do	Boulder mine	Do.
Do	Butts mine	Do.
Do	Doig mine	Do.
Do	Monahan mine	Do.
Do	St. Lawrence mine	Do.
Do	St. Patrick mine	Do.
Do	Butte Bar mine	Plumas.
Do	Crescent mine	Do.
Do	Eureka mine	Do.
Do	Eureka Mills mine	Do.
Do	Indian Valley mine	Do.
Do	Nelson mine	Do.
Do	Prattville	Do.
Do	Rich Gulch	Do.
Gold quartz (2)	Alvord mine	San Bernardino.
Gold quartz	Oro Grande mine	Do.
Do	Saragossa mine	Do.

List of Californian exhibitors of the precious metals—Continued.

Specimen.	Mine or locality.	County.
Gold quartz	Antelope mine	San Diego.
Do	Carga Muchacha mine	Do.
Do	Cincinnati Belle mine	Do.
Do	Eureka mine	Do.
Do	Gold King mine	Do.
Do	Peterson mine	Do.
Do	Ready Relief mine	Do.
Gold quartz (2)	Stonewall mine	Do.
Gold quartz	Black Bear mine	Shasta.
Do	Calumet Group mine	Do.
Do	Chandler-Smith mine	Do.
Do	Gladstone mine	Do.
Do	Juniper mine	Do.
Do	Mammoth mine	Do.
Do	Niagara mine	Do.
Do	Oak Consolidated mine	Do.
Do	Ono mine	Do.
Do	Reed Consolidated mine	Do.
Do	Reilly & Bliss mine	Do.
Do	Texas Consolidated mine	Do.
Do	Uncle Sam mine	Do.
Do	Gold Bluff mine	Sierra.
Do	Sierra Buttes mine	Do.
Do	Young America mine	Do.
Do	Black Bear mine	Siskiyou.
Do	Columbia mine	Do.
Do	Gold Ball mine	Do.
Do	Gold Run mine	Do.
Do	Schroeder & Werner mine	Do.
Do	Scotts Bar mine	Do.
Do	Brown Bear mine	Trinity
Do	Buck mine	Do.
Do	Bully Choop mine	Do.
Do	Cumberland mine	Do.
Do	Gold Chest mine	Do.
Do	Alameda mine	Tuolumne.
Do	Alhambra mine	Do.
Gold (in talc with chalcopyrite)	Suffolk mine	Calaveras.
Gold crystal	Bull Creek	Mariposa.
Gold ore	Kehoe mine	Do.
Do	Duncan mine	Do.
Gold, placer	Red Point mine	Placer.
Do	Rancheria Gulch	Siskiyou.
Do	Center mine	Trinity.
Do	Hayes mine	Do.
Do	Mammoth mine	Do.
Do	McMurray & Hupp mine	Do.
Do	Red Flat mine	Do.
Do	Smith Watson's mine	Do.
Gold nugget (weight, 30 ounces)	Blue Wing mine	Placer.
Gold in leaf form, partially crystallized	Kelsey	El Dorado.
Gold in quartz (crystallized)	Lovelock	Butte.
Gold in quartz (1,500-foot level)	Idaho mine	Nevada.
Gold in quartz (cut and polished)	Diadem mine	Plumas.
Gold in wire form	Green Mountain mine	Siskiyou.
Gold quartz	Amador Queen mine	Amador.
Do	Nevill's mine	Do.
Do	Plymouth Consolidated	Do.
Do	Moore mine	Do.
Do	North Star mine	Do.
Do	Excelsior mine	Do.
Do	Washington mine	Calaveras.
Do	Star of the West mine	Do.
Do	Knox & Osborne mine	Do.
Do	Big Blue mine	Kern.
Do	Topeka mine	Los Angeles.
Do	Padre mine	Do.
Do	Bodie mine	Mono.
Gold quartz (2)	Last Chance mine	Monterey.
Do	Idaho mine	Nevada.
Gold quartz	Mountaineer mine	Do.
Do	Nevada County mine	Do.
Do	Original Empire mine	Do.
Do	Big mine	Placer.
Do	Doig mine	Do.
Do	Gold Blossom mine	Do.
Do	Grizzly Ridge mine	Plumas.
Do	Butte Bar mine	Do.
Do	Florence & Little mine	Do.
Gold quartz (2)	Old Woman's Mountain	San Bernardino.
Gold quartz	Eureka mine	Shasta.
Do	Washington mine	Do.
Do	Cleveland mine	Sierra.
Do	Gold Run mine	Siskiyou.

List of Californian exhibitors of the precious metals—Continued.

Specimen.	Mine or locality.	County.
Gold quartz	Little Gem mine	Trinity.
Gold quartz (2)	Heslep mine	Tuolumne.
Gold quartz	Harrison & Morton mine	Do.
Do	Carlotta mine	Do.
Do	New Albany mine	Do.
Do	Wallis mine	Yuba.
Gold ore (3)	Reed	Shasta.
Gold ore	Schneider	Do.
Do	Snyder mine	Do.
Gold ore (corellie)	Squaw Creek	Do.
Gold ore	Sunny Hill	Do.
Gold ore (1 vial)	Cherokee	Butte.
Gold ores (6 specimens)		Do.
Gold quartz (2 specimens)		Do.
Gold quartz (2 pieces)	Defiance mine	Do.
Gold quartz	Oregon City	Do.
Do	Yankee Hill	Do.
Gold quartz, sulphurets (3 specimens)		Do.
Gold and silver ore		Do.
Gold, silver, copper (galena)		Do.
Gold in washed quartz gravel	Defiance mine	Do.
Platina grains (1 vial)	Spring Valley hydraulic mine	Do.
Pyrolusite (4 specimens)		Do.
Quartz (5 specimens)		Do.
Quartz	Strange mine	Do.
Quartz and gold		Do.
Quartz with telluride (4 specimens)		Do.
Loaned by Shasta County:		
Country rock	Igo district	Shasta.
Galena (5 specimens)	Cow Creek	Do.
Gold ore	Connor mine	Do.
Do	Dayton	Do.
Do	Empire mine	Do.
Do	Gray Eagle	Do.
Do	Little Nellie	Do.
Do	Midnight	Do.
Do	Mountain Queen	Do.
Do	Nigger mine	Do.
Do	Pfeiffe	Do.
Do	Reed mine	Do.
Magnetic iron	Arbuckle district	Do.
Silver ore	Richmond mine	Do.
Do	Uncle Sam mine	Do.
Wall rock	Old Diggings	Do.
Gold ore	Bell mine	Do.
Do	Black Hawk	Do.
Do	Chicago mine	Do.
Gold ore (telluride)	Cleveland	Do.
Gold ore (9)	Connor mine	Do.
Gold ore	Dayton	Do.
Do	Dog Creek	Do.
Do	Ellis	Do.
Do	....do	Do.
Do	Empire	Do.
Do	Falls	Do.
Do	Gray Eagle	Do.
Do	Hart mine	Do.
Do	Little Nellie	Do.
Do	Live Oak	Do.
Do	Midnight	Do.
Do	Mountain Queen	Do.
Do	Mountain Rose	Do.
Do	Nigger mine	Do.
Do	Pfeiffe	Do.
Loaned by Plumas County (S. S. Taylor):		
Gold dust (7 vials)		Plumas.
Gold, placer (4 nuggets)	La Porte	Do.
Gold quartz (1 large, 5 small pieces)		Do.
Bowlder containing gold		Do.
Gold leaf (1 bottle, marked $4)		Do.
Platinum (1 bottle)	Silver Star hydraulic mine	Do.
Gold dust (6 vials)		Do.
Gold, placer (4 nuggets)	La Porte	Do.
Gold quartz (1 large, 5 small pieces)		Do.
Loaned by John Daggett:		
Gold quartz (8 specimens)	Black Bear mine	Siskiyou.
Gold quartz	California Queen, Cottonwood district	Do.
Gold quartz (10 specimens)	Doe & Daggett mine	Do.
Gold quartz	Live Yankee mine	
Loaned by J. Z. Davis:		
Diamonds, perfect octahedron, with modified planes showing 24 edges, weight 1$\frac{1}{32}$ carats.	Volcano	Amador.
Diamonds (2)	North Bloomfield mine	Nevada.

List of Californian exhibitors of the precious metals—Continued.

Specimen.	Mine or locality.	County.
Loaned by J. Z. Davis—Continued.		
Diamond found at mouth of South Fork of the Yuba River in 1850, weight $\frac{3}{32}$ carats.	Yuba River	
Gold, crystallized, in quartz (10 specimens.)		Mariposa.
Gold, crystallized, white quartz	Nigger Hill	Tuolumne.
Gold, in leaf form	do	Do.
Loaned by P. Deidesheimer:		
Model of mine-timbering		
Loaned by S. W. Dorsey and A. Tregidgo:		
Gold quartz	Idaho mine	Nevada.
Loaned by A. C. Hamilton:		
Model of mine-timbering		
Loaned by R. McMurray:		
Auriferous gravel	North Bloomfield mine	Do.
Gold in quartz (12 specimens)	Delhi mine	Do.
Gold nugget ($140)	do	Do.
Loaned by G. A. Wilson:		
Quartz with free gold (2 specimens)		Fresno.
Silver ore	Ygnacio mine	Inyo.
Do	Al Bunnel mine	Kern.
Do	Cinderella mine	Do.
Do	Old Billy mine	Los Angeles.
Do	Diana mine	Mono.
Do	Garibaldi mine	Do.
Do	Golden Crown mine	Do.
Do	Kerrick mine	Do.
Do	Mammoth mine	Do.
Do	Jupiter mine	Do.
Do	Grigsby mine	Napa.
Do	Silverado mine	Do.
Do	Venus mine	Do.
Do	Belle McGillivray mine	San Bernardino.
Do	Bismarck mine	Do.
Do	Bonanza mine	Do.
Do	Everett mine	Do.
Do	Garfield mine	Do.
Do	Gobbler mine	Do.
Do	Ivawatt mine	Do.
Do	King mine	Do.
Do	Lydia Hatzel mine	Do.
Do	Occidental mine	Do.
Do	Silver Monument mine	Do.
Do	Walhalla mine	Do.
Do	Waterloo mine	Do.
Do	Rainbow mine	Inyo.
Do	Richmond mine	Do.
Do	Occidental mine	Kern.
Do	Kerrick mine	Mono.
Do	Mount Gibbs	Do.
Do	Exchequer mine	Alpine.
Do	Morning Star mine	Do.
Do	Pennsylvania mine	Do.
Do	Advance mine	Do.
Do	Altura mine	Do.
Do	Washington mine	Do.
Do	Best Chance mine	Fresno.
Silver ore with lead	De Soto mine	Do.
Silver ore with zinc	Yosemite Queen mine	Do.
Silver ore with gold	Zebra mine	Do.
Silver ore	Cactus mine	Inyo.
Silver ore (galena)	Defiance mine	Do.
Do	Driver mine	Do.
Silver ore	Gladitor mine	Do.
Do	Gray Eagle mine	Do.
Do	Great Eastern mine	Do.
Do	Great Western mine	Do.
Do	Greenly & Broder mine	Do.
Do	Gunsight mine	Do.
Do	Hildalgo mine	Do.
Do	Little Chief mine	Do.
Do	Mabel mine	Do.
Do	Minerva mine	Do.
Silver ore (galena)	Modoc mine	Do.
Silver ore	Mountain View mine	Do.
Do	New Coso mine	Do.
Silver ore (2)	Rainbow mine	Do.
Silver ore	Shiloh mine	Do.
Silver ore (galena)	Tower mine	Do.

STATISTICS OF THE PRODUCTION OF GOLD IN CALIFORNIA.

I am indebted to the State mineralogist of California for the following tables of gold production in California. There is some variation in the different estimates.

Gold production of California from 1848 to 1894, inclusive.

[Authorities, W. P. Blake, R. W. Raymond, J. J. Valentine.]

1848	$5,000,000	1864	$30,000,000	1881	$17,166,676
1849	25,000,000	1865	28,000,000	1882	15,520,325
1850	50,000,000	1866	26,000,000	1883	13,841,297
1851	55,000,000	1867	25,000,000	1884	12,896,594
1852	60,000,000	1868	23,000,000	1885	12,338,014
1853	65,000,000	1869	20,000,000	1886	13,208,034
1854	60,000,000	1870	18,632,972	1887	11,836,957
1855	56,000,000	1871	16,167,484	1888	10,076,091
1856	55,000,000	1872	19,049,098	1889	10,329,044
1857	54,000,000	1873	18,052,722	1890	9,896,851
1858	50,000,000	1874	17,617,124	1891	10,455,488
1859	48,000,000	1875	16,326,211	1892	10,361,486
1860	35,000,000	1877	15,237,729	1893	11,172,036
1861	40,000,000	1878	17,306,508	1894	12,540,146
1862	38,000,000	1879	18,190,973		
1863	35,000,000	1880	17,745,745	Total	1,253,115,604

Gold production of California from 1848 to 1894, inclusive.

[Authorities, L. A. Garnett and United States mint reports.]

1848	$245,301	1865	$17,930,858	1882	$17,146,416
1849	10,151,360	1866	17,123,867	1883	17,256,873
1850	41,273,106	1867	18,265,454	1884[a]	[2]20,660,000
1851	75,938,232	1868	17,555,867	1885	12,661,044
1852	81,294,700	1869	18,229,044	1886	14,716,506
1853	67,613,487	1870	17,458,133	1887	13,588,614
1854	69,433,931	1871	17,477,885	1888	12,750,000
1855	55,485,395	1872	15,482,194	1889	11,212,913
1856	57,500,411	1873	15,019,210	1890	12,309,793
1857	43,628,172	1874	17,264,838	1891	12,728,869
1858	46,591,140	1875	16,876,009	1892	12,571,900
1859	45,846,599	1876	15,610,723	1893	12,422,811
1860	44,095,163	1877	16,501,268	1894	13,863,281
1861	41,884,995	1878	18,839,141		
1862	38,854,668	1879	19,626,654	Total	1,244,822,896
1863	23,591,730	1880	20,030,761		
1864	24,071,423	1881	19,223,155		

[a] From 1884 estimated on mint basis. [2] One-half year on mint basis, to even up Garnett's fiscal year.

United States mint record of California bullion product.

Year.	Gold.	Silver.	Total.
1894	$13,923,281.89	$297,331.55	$14,220,613.44
1893	12,422,811.60	537,157.77	12,959,969.37
1892	12,571,900.57	436,602.46	13,035,503.03
1891	12,728,869.78	953,157.48	13,682,027.26
1890	12,309,793.08	1,060,613.10	13,370,406.18
1889	11,212,913.68	754,793.19	11,967,706.87
1888	12,750,000.00	1,700,000.00	14,450,000.00
1887	13,588,614.18	1,632,003.91	15,220,618.09
1886	14,716,506.40	1,610,625.50	16,327,131.90
1885	12,661,044.71	2,568,035.91	15,229,080.62
1884	13,600,000.00	3,000,000.00	16,600,000.00
1883	14,120,000.00	1,460,000.00	15,580,000.00
1882	16,800,000.00	845,000.00	17,645,000.00
1881	18,200,000.00	750,000.00	18,950,000.00
1880	15,618,361.00	1,140,556.00	16,758,917.00

Wells, Fargo & Co.'s annual statement of bullion product of California.

[By J. J. Valentine.]

Year.	Gold dust and bullion by express.	Gold dust and bullion by other conveyances.	Silver bullion by express.	Ores and bars bullion by freight.	Total.
1871	$16,167,484	$3,279,870	$231,870	.....	$19,447,354.82
1872	16,493,922	1,649,392	233,665	$673,116	19,049,098.00
1873	15,709,956	1,570,995	204,771	480,000	18,025,722.00
1874	16,015,568	1,601,556	967,857	1,715,550	20,300,531.00
1875	14,842,010	1,484,201	387,768	1,039,172	17,753,151.00
1876	14,635,963	1,463,596	796,308	1,719,940	18,615,807.00
1877	14,512,123	725,606	1,202,751	1,734,236	18,174,716.00
1878	16,482,389	824,119	809,431	804,522	18,920,461.00
1879	16,348,730	817,436	739,440	285,367	18,190,973.00
1880	16,900,745	845,000	378,567	151,854	18,276,166.00
1881	16,349,216	817,460	548,582	305,421	18,020,679.00
1882	14,736,682	736,682	509,342	352,831	16,332,498.00
1883	13,182,188	659,109	1,171,748	660,269	15,673,314.00
1884	12,282,471	614,123	1,504,705	871,618	15,272,988.00
1885	11,750,490	587,524	1,608,500	1,090,158	15,036,672.00
1886	12,579,356	628,678	918,403	568,948	14,690,385.00
1887	10,760,052	1,076,905	972,707	853,259	13,662,923.00
1888	9,160,083	916,008	652,652	1,334,725	12,063,468.00
1889	9,390,044	939,000	664,476	1,849,237	12,842,757.00
1890	8,605,958	1,290,893	670,184	1,194,079	11,761,114.00
1891	9,140,772	1,350,716	475,745	1,284,000	12,215,233.00
1892	8,961,486	1,400,000	351,139	885,571	11,598,196.00
1893	9,697,036	1,475,000	257,008	1,667,907	13,096,948.00
1894	10,690,646	1,850,000	183,305	1,464,631	14,188,582.00

NEVADA.

By the courtesy of the Inyo Development Company, through J. A. Gerrington, esq., Carson City, I am able to give an estimate of the past and present output of the mines as represented by exhibits at Chicago. He estimates the total at $600,000,000 in value of gold and silver. Unfortunately the weight of these metals, respectively, is not given. The production of the Comstock lode up to September 30, 1892, was, in value: Gold, $145,297,039.17; silver, $206,396,412.83; value of total, $351,693,452. The remainder, or balance, of the total production of the State was chiefly in silver from the following-named mining camps or centers: Eureka, Hamilton, Tuscarora, Austin, Candelaria, Tybo, and Belmont. Aurora produced $13,000,000 in value of gold. Silver City, Pine Grove, Hawthorne district, Kennedy, Silver Peak, Robinson district, Ferguson district (now De Lamar), Como, Silver Star district, Buckeye (placer), Osceola, Pine Nut, and numerous mines not designated as being in any particular district were represented with specimens of their gold ores. There has since the Exposition closed been a notable revival of interest in gold mining throughout the State, particularly in the northern and eastern portions. The Gold Hill region of Deep Creek is a particularly interesting one, inasmuch as it appears to be on the north and south line of many gold-producing localities from the Osceola placers, where an abundance of coarse gold nuggets has been found. This north and south gold region, as I have shown, is coincident with the development of the Carboniferous, or mountain limestone, and at

Gold Hill, at least, is connected with the metamorphism of this limestone by intruded dikes of granite and other plutonic rocks. Coarse gold of high grade occurs in a gangue or veinstone of tremolite, one of the products of the alteration of the limestone.

The demonetization of silver, and its consequent low value, having necessitated the closing down of many of the formerly most productive mines has, on the other hand, made a greater demand for gold properties, and has infused new life into many of the gold-producing camps.

The Buckeye placer claims, situated some 30 miles north of Carson, have been purchased, and a ditch some 55 miles in length has been projected to fetch water to them at a cost of $500,000. In October, 1895, the De Lamar mines were producing about $27,000 in value in gold weekly. The Hawthorne mines were also producing. At the Pamlico mine 101 tons of ore yielded $116,000 in value.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

This society, by its secretary, Prof. Rossiter W. Raymond, exhibited a set of its transactions, 1871 to 1891, in which many papers relating to the metallurgy and production of the precious metals may be found.

RUSSIA.

The mining department of the ministry of public domains exhibited an obelisk showing the amount of gold obtained from 1745 until 1892 in European Russia and Siberia. The quantity from European Russia was 458,843.989 kilograms, and from West Siberia 109,990.414 kilograms; from East Siberia 1,097,231.632 kilograms. The production for the decade preceding 1893 varied, as shown in the annexed table:

Table showing the production of gold for ten years in European Russia and in Siberia.

[Stated in kilograms.]

Year.	Cabinet of his Imperial Majesty.	East Siberia.	West Siberia.	Urals.	Finland.	Total.
1883	1,654	23,883	2,113	8,075	8.2	35,733.2
1884	1,491	24,048	2,031	7,961	.....	35,531
1885	999	21,245	2,064	8,698	12.2	33,018.2
1886	1,687	20,525	2,047	9,172	5.5	33,436.5
1887	1,556	20,426	2,227	10,647	5.5	35,861.5
1888	1,409	20,508	2,326	10,909	12.2	35,164.2
1889	1,736	22,441	2,539	10,516	24.6	37,256.6
1890	1,867	24,530	2,432	10,524	16.4	39,369.4
1891	.....	20,377	7,101	11,532	.....	39,010
1892	1,818	22,130	7,265	11,925	.....	43,138
Total	14,217	220,113	32,145	99,959	84.6	366,518.6

GERMAN EMPIRE.

Only a small part of the production of gold and silver in Germany is from native sources; the greater part is from foreign ores and intermediate products. In the year 1890 the production amounted to 403 tons of silver, valued at 56,000,000 marks, or approximately $14,000,000. The greater portion of this output was from the government district of Aix-la-Chapelle, mainly by the works in Stolberg. The Kingdom of Saxony produced 84 tons; the Upper Harz (Clausthal and Lautenthal), 47; the district of Wiesbaden (Ems), 20; and Upper Silesia only 9 tons.

The production of silver is always connected with the smelting of lead and copper.

Gold is produced very sparingly from native ores, but to the extent of 3,710 pounds from silver separated from imported ores (Spanish, Chilean, Mexican, etc.) of lead, copper, and silver.

The extraction of gold and silver by lixiviation processes was represented by the Deutsche Gold and Silberscheideanstalt vorm. Roessler, Frankfort-on-the-Main; which company also had exhibits in classes 57 and 55 illustrative of their operations in separating gold and silver by cupellation and by milling.

BRAZIL.

The commission of the State of Minas Geraes sent a large gilded pyramid, representing the bulk and weight of the gold extracted from the mines of the State during the period of a century from 1720 to 1820. The total weight was 615,000 kilograms, valued at 500,000 contos of reis. The commission also exhibited a map of the gold mines of Minas Geraes, by Prof. Paul Ferrand. The Dom Pedro Gold Mining Company, Limited, sent photographs of the mines of Jacutinga. Photographs of other mines in the Minas Geraes district were also sent by the Ouro Preto Gold Mining Company, Limited, and the Minas de Ouro de Faria.

The S. John del Rey Gold Mining Company, Limited, made a fine exhibition of photographs, maps, plans, and sections of the mines under their control, with statistics of productions and three superposed gilded cubes representing the production, expenses, and net profit of the gold mines of Morro Velho during the period of fifty years from 1836 to 1886. Of these cubes, the largest represented the weight of 46.55 tons of gold, and the value of £5,178,657 15s. 1d.; the second the weight of 31.49 tons, and the value of £3,502,895 17s. 11d., and the smallest the weight of 15.06 tons, and value of £1,675,761 17s. 2d.

NEW SOUTH WALES.

The commission of New South Wales, and notably the committee of seven in charge of the preparation of the exhibit under the head of mining and metallurgy, deserve thanks and great commendation for the very complete manner in which they presented the subject by statistics and carefully prepared introductions and explanatory statements accompanying the objects sent for exhibition. In the following notices free use has been made of this information, much of which is extracted bodily from the pages of the catalogue of New South Wales, Department E, mines and mining.

PRODUCTION OF GOLD IN NEW SOUTH WALES.

The production of gold in New South Wales up to the end of the year 1891 was 10,373,452 ounces, valued at £38,633,417 17s. 10d., and of silver, silver lead, and ore, as follows: Ingots, 4,941,138 ounces; silver lead, 199,616 tons; ore, 219,716 tons; value, £11,302,095.

Gold mining, as hitherto carried on, has been principally confined to the working of river beds and shallow alluvial claims and leads; in some instances the latter have been worked to a depth of 200 feet. Extensive areas of country are known to be auriferous, and there are the strongest indications of deep leads in various parts where no attempt has been made to work them. Except in some few localities, quartz veins have not been worked to a great depth. The deepest mine in the colony is at Adelong, where payable quartz has been raised from a depth of 1,050 feet. The poor success which has often attended the working of quartz mines is largely attributable to ill-judged speculation, inexperience, and the absence of proper ore-separating and other mining appliances. It is known that much gold passes away in the tailings, and is lost in consequence of the imperfect appliances at present employed for the treatment of auriferous pyrites. Quartz mining is, however, steadily progressing. Rich auriferous antimony reefs have been opened at Hillgrove, near Armidale. From the Bakers Creek gold mine, in this locality, 1,307 tons of stone yielded 17,293 ounces of gold—an average of 13 ounces 4 pennyweight 15 grains per ton. Bulk samples of auriferous gossan and pyritous ore from the lately discovered lodes at Peak Hill are exhibited. Specimens of auriferous quartz and samples of alluvial gold from various gold fields are also shown. One specimen of quartz from the Mother Shipton reef, at Temora, contains 258 ounces of gold. Among the alluvial specimens the Maitland bar nugget, containing 313 ounces of fine gold, is conspicuous.

Mining for gold in Australia commenced in the year 1851, but the discovery is recorded as far back as 1823. Mr. Surveyor M'Brian, in his field notes of the survey of the Fish River, between Tarana and O'Connell, states:

> February 15, 1823. At 81.50 to river, and marked gum tree. At this place I found numerous particles of gold in the sand in the hills convenient to the river.

Recent investigation, indeed, has brought to light a Portuguese chart of the sixteenth century, on which the northwest coast of Australia has been marked as "the gold coast."

In 1839 Count Strzelecki found auriferous pyrites near Wellington.

In 1841—23d and 24th February—Rev. W. B. Clarke, M. A., F. R. S., discovered gold in situ in the granite formation betweeen Hartley and Hassans Walls, and at the head of Winburndale Rivulet. He very shortly afterwards spoke of the abundance of gold likely to be found in the colony, and as early as 1843 mentioned it generally. In 1844 he showed a sample to the governor of New South Wales, Sir George Gipps, who said, "Put it away, Mr. Clarke, or we shall all have our throats cut."

Prof. Sir Archibald Geikie, director of His Majesty's geological survey of Scotland, in his Life of Murchison, thus refers to Mr. Clarke's discovery of gold:

> The first explorer who proclaimed the probable auriferous veins of Australia on true scientific grounds—that is, by obtaining gold in situ and tracing the parent rock through the country—was the Rev. W. B. Clarke, M. A., F. R. S., who, originally a clergyman in England, has spent a long and laborious life in working out the geological structure of his adopted country, New South Wales. He found gold in 1841, and exhibited it to numerous members of the legislature, declaring at the same time his belief in its abundance. While, therefore, geologists in Europe were guessing, he, having actually found the precious metal, was tracing its occurrence far and near on the ground.

In 1843 or 1844, Macgregor, a shepherd, is said to have found gold in the Wellington district.

On April 3, 1851, Mr. E. H. Hargraves, who had recently returned from California, addressed a letter to the colonial secretary stating that he had been prospecting for two months, and offered to point out the localities in which he had discovered gold to any officer of the government on condition of the government awarding him £500 as a compensation. To this the government directed that a similar answer should be given to that returned to the former proposal of Mr. Smith.

The distance between the Albert gold field and the Delegete gold field being 672 miles, and between the latter and the Ballina gold field being 600 miles, it will be seen that gold fields are distributed over the greater part of the colony. Notwithstanding that the search for gold has been carried on for forty years, new fields or new deposits are continually being discovered, some of them in localities which were

supposed to have been thoroughly examined, while the older fields, though apparently exhausted as far as the miner, unaided by capital and skill, is capable of exhausting them, yet contain deposits of gold which will yield a rich harvest to the skilled miner who shall bring to bear upon them appliances such as are being successfully employed elsewhere.

In order to encourage the introduction of such a system of mining as will lead to the profitable working of localities from which the operative miner can no longer extract a living by means of the pick and shovel alone, it will be necessary to provide security of tenure over comparatively large areas subject to the employment of necessary appliances and labor.

Gold has always been found in association with certain formations, and the extent of country occupied by these is about 70,000 square miles, or nearly one-fourth of the whole area of the colony, a considerable portion of which has not yet been touched by the pick of the miner.

Gold-bearing quartz reefs have been found in New South Wales in sedimentary rocks of Upper Silurian, Devonian, and Carboniferous ages, also in hornblendic granites, porphyry, diorite, basalt, and serpentine, while the deposits which contain alluvial or waterworn gold in payable quantity, and which have been derived from the degradation of these formations, are of Permian, Cretaceous, Tertiary, and Quaternary ages.

Auriferous quartz reefs in the Upper Silurian formation have been worked at Hill End and Tambaroora, Trunkey, Temora, Mount Brown, etc.; in the Devonian, at Nana Creek, Boorook, etc.; in the Carboniferous, at Barrington or Copeland; in granites, at Braidwood, Adelong, Timbarra, etc.; in porphyry, at Grenfell; in diorite, at Gulgong, Temora, Parkes, etc.; in serpentine, at Gundagai, Lucknow, etc. The reefs vary from a few inches to 10 feet in width, though occasionally they attain a greater thickness. They generally have meridional strike, especially where they traverse the Silurian formation; but in many localities the strike runs in other directions. Thus at Hill End, Trunkey, and Adelong, the prevailing strike is about N. and S.; at Dalmorton, from E. 10° N. to E. 30° S.; at Grenfell, NE.; at Temora and Copeland, from NE. to E. and SE.

In these reefs the gold seldom occurs without one or more of the following sulphurets: Pyrites, galena, mispickel, blende, and copper pyrites; calcite is also frequently present, and barytes rarely. At Hill End portions of the reefs contain potash mica (muscovite).

In some places the mica was found to entirely replace the quartz, and here the gold was found to be excessively rich.[a]

[a] See geological map of Hill End and Tambaroora, by E. F. Pittman, geological surveyor.

These reefs traverse chlorite slate, clay slates, and metamorphosed conglomerates; the latter contain obscure impressions of *Encrinites*, *Spirifera*, and *Farosites*.

At Hill End reefs of phenomenal richness were worked about 1871–72 to comparatively shallow depths on the summit of the hill. To prove their persistence in depth, a tunnel (crosscut) has lately been driven into the base of the hill at a level 1,200 feet below the outcrop of the veins on the hill summit. This practical prospecting has been rewarded by the discovery of three payable reefs, which, though small, are rich. It is probable that a considerable revival in reefing will ensue in this district.

Important discoveries of gold-bearing lodes have recently been made at Peak Hill, in the Parkes district, and at Pambula, on the south coast. In both places large deposits of payable stone have been proved by prospecting operations.

Owing to the fineness of the gold and the peculiar nature of the gangue in the Pambula lodes, considerable difficulty has been experienced in saving the gold by mechanical treatment; chlorination is needed to efficiently treat the ore. The gangue is essentially felspathic, consisting of silicate of alumina and free silica. The richness of some of the lodes may be judged by the yield from 120 tons from the Faulkner mine, viz, 1,890 ounces.

The Peak Hill lodes have been proved to yield from half to 1 ounce of gold per ton.

The rich quartz veins at Lucknow occur along the line of junction of serpentine and hornblende porphyry. Besides quartz the vein stuff includes calcite, asbestus, serpentine, and abundance of mispickel; also a little magnetite. The gold is sometimes visibly disseminated through the mispickel and serpentine.[a]

At Barmedman, in the Bland district, Mount Hope, in the Lachlan district, and at Cowarbee, in the Murrumbidgee district, gold is not only found in the veins of quartz with pyrites and galena, but also in the cleavage planes and joint fissures of the adjoining slates. Near Glen Innes, in the New England district, it has been found in bismuth ores.

At the Browns Creek mine, 6 miles west from Blayney, an immense breccia lode has been worked for many years. The gold is disseminated in fine particles throughout the lode, and also in hard siliceous accretions which have been formed by segregation in the lode stuff. The gold, therefore, has evidently been deposited from solution. The lode has been extensively worked, and yields an average of about 3 pennyweights per ton.

In the Hillsgrove district, Lunatic, and at Ilford gold occurs in

[a] See report on Wentworth gold field, by C. S. Wilkinson, F. G. S., F. L. S., government geologist, in Annual Report Department of Mines.

quartz reefs associated with antimony sulphide. Owing, however, to the present imperfect appliances for separating gold from antimony, a considerable proportion of the value of the gold in the antimony ore is not realized.

At Deep Creek, Nambucca, a valuable lode of auriferous mispickel is now being practically operated upon by a chlorination process, the contained arsenic being obtained as a marketable commodity, as also the sesquioxide of cobalt, which is present in the ore to the extent of 1½ per cent.

Rich gold has been found in a calcite gangue at Ti-tree, near Manilla.

On several of the gold fields, the reefs contain much pyrites, which, on assay, have been proved to be more or less rich in gold. New South Wales certainly affords a very promising field for the introduction of efficient economic appliances for the extraction of gold from pyrites.

Throughout the gold fields, gold is always found to be more or less alloyed with silver and occasionally with traces of copper, iron, osmo-iridium, and other metals.

The greatest depth at which auriferous reefs have been worked in New South Wales is 1,050 feet, viz, in the Adelong united gold mine, Adelong.

At Araluen, Uralla, Timbarra, the granite diggings, near Mount Brown, and other diggings where the formation consists of granite, the gold in the alluvium has evidently not only been derived from quartz reefs but also from the granite rock itself.

Near Rockley gold occurs in altered talcose schists.

The Permian deposits consist of pebble conglomerates, forming the base of the Coal Measures, or "Glossopteris beds," at the Tallawang diggings, and resting upon the Silurian schists traversed by quartz reefs from which the gold must originally have been derived. The conglomerate yields from 1 to 15 pennyweights of gold per ton, while nuggets weighing 5 ounces have been obtained from it. The gold is generally in the form of flat scaly pieces, and waterworn.

Gold has been recently discovered in the marine conglomerates and shale beds, which are believed to be of Cretaceous age, and which rest upon the flanks of the Silurian, Devonian, and granite formations in the Mount Brown or Albert gold field.*

Of the Tertiary deposits, gold in payable quantity has been obtained from the Lower, Middle, and Upper Pliocene alluvia, chiefly from the two latter. Some of the deposits may be of Miocene or Eocene age. These are of fresh-water origin, and consist of ancient river drifts of pebbles, sand, and clays, the remains of auriferous formations which had been disintegrated by denuding agencies during the erosion of the valleys. "The fossils found in these fluviatile deposits or 'deep leads'

*See Report upon the Albert Gold field, by Henry Y. L. Brown, gelogical surveyor.

of the Middle and Upper Pliocene beds are very numerous. Large trunks, branches, leaves, and fruits of trees, with ferns, bones of extinct marsupials and birds, remains of insects and fresh-water mussel shells, have been exhumed from the clays and gravels of these old river beds. Of the fossil fruits, Baron von Mueller, K. C. M. G., M. and Ph. D., F. R. S., the distinguished government botanist of Victoria, whose researches have thrown so much light upon the character of the vegetation of this period, has described no less than 13 genera and 16 species of extinct forms, some of which have living allies."

In many localities the old river beds, or "leads" as the miners term them, have been overwhelmed by flows of volcanic rocks, which are sometimes 200 feet thick; consequently shafts have to be sunk through the basalt, as on the Forest and other gold fields, to reach the gold-bearing gravels; but where, as on the Cudgegong River, the basalt has been completely cut through by the subsequent erosion of the valleys, the leads may be readily worked from adits driven under the basalt.

From 1,546 loads of wash dirt from one of the rich claims (four men's ground) on the Happy Valley lead, near Gulgong, 6,203 ounces of gold were obtained; and from a claim on the Canadian lead, on the same gold field, seven men in three years obtained, free of all expenses, gold to the value of £28,000. One ounce of gold per load, though above the average yield, is not an uncommon return from the wash dirt of the Pliocene leads. But upon the Gulgong, Parkes, Forbes, and other fields of gold-bearing fame, some of the leads have been followed into deep ground where, owing to the heavy influx of water, they could not be further profitably worked by the ordinary manual efforts of the miners. However, with the aid of steam power and improved gold-saving appliances, they will probably afford remunerative employment for many years to come.

During the past year drill boring has been successfully prosecuted in the Gulgong gold field, and by this means 1½ miles of an alluvial lead has been proved, at an average depth of about 160 feet, the wash averaging from 2 feet to 3 feet 8 inches in thickness.

The Quaternary or Post-Pliocene and recent gold-bearing drifts are found in all the alluvial flats through which the rivers and creeks meander, and in the more shallow ground, or "surfacing," upon the sides and summits of the hills, in proximity to the rocks and reefs from which the gold has been derived. On many of the gold fields these deposits proved immensely rich, and on account of the facility with which they could be worked, by even inexperienced miners, they were quickly exhausted, excepting in localities where water was scarce, and there are many such places, where the surfacing will pay to rework by ground sluicing when a sufficient supply of water can be brought to operate upon it.

On the Mount Brown gold field, in the northwest part of the colony, where there is a scarcity of water owing to the aridity of the climate, large quantities of gold have been obtained from the alluvial by dry blowing, which is a tedious and troublesome process for the miners. Latterly, however, two patents have been taken out—one by Messrs. C. Phillips & Co. and the other by Captain Park—for inventions of dry-blowing machinery for treating dry and loose gold-bearing deposits. Public trials of these machines proved successful.

The quantity of gold raised in the colony to the end of 1891 amounted to 10,373,452 ounces of a value of £38,633,477.

SILVER.

Silver mining in New South Wales dates from the opening of the Boorook silver-bearing lodes near Tenterfield, New England, in 1879. The lodes, which are several in number, occur in belts of feldspar porphyry, alternated with beds of fossiliferous shales of Lower Carboniferous age. From the surface to the water level the ores consisted of soft ferruginous clay stones and quartz, carrying chloride and a little iodide of silver and gold in payable quantity; below the water level the ores changed to bluish clay stones and quartz, carrying pyrites and a little blende, and became more difficult of treatment. A considerable amount of silver and gold was obtained from the more easily worked surface ores.

In 1884, however, silver mining in the colony practically became established as an important and rapidly increasing source of national wealth, for in that year the silver lodes of the Barrier Ranges in the extreme western portion of the colony, those of Sunny Corner or Mitchell, in the Bathurst district, and the Emmaville and Pyes Creek lodes in the New England district were opened.

The value of the silver, silver lead, and silver ore produced in the colony up to the 31st December, 1891, amounted to £11,302,095.

Referring to Broken Hill, where the now celebrated silver mine is situated, Mr. C. S. Wilkinson, F. G. S., F. L. S., the late government geologist, says:

> Broken Hill, so called from the rugged outline of its rocky summit, is the highest point on a narrow ridge, which runs northeast and southwest for several miles, and forms a conspicuous feature in the district, rising for about 150 feet above the general level of the undulating plain country on each side. The crest of the ridge is formed by the outcropping of a huge lode. The lode varies in width from 10 to 120 feet, and in places rises above the surface in large, craggy, black masses (manganiferous oxide of iron).

The same authority, in describing this lode on a subsequent occasion, when it had been proved to a depth of 316 feet, states that—

> It is a true fissure lode, varying in width from 10 feet to 160 feet, and consists chiefly of porous iron and manganese oxides, in places more or less silicious, contain-

ing carbonate of lead and chloride of silver, with occasionally carbonates of copper and zinc. The lode continues northerly with much the same character, narrowing and widening in places through Block 14, Blocks 15 and 16 (British blocks), and Broken Hill Junction, beyond which it seems to continue in irregular smaller lodes of a more silicious nature, containing argentiferous galena and carbonates of lead and copper, with a little chloride of silver. To the south it passes into quartzite lodes, containing silver, lead, and copper ores sparingly distributed through the lode stuff.

From the following figures extracted from the reports of the Proprietary Company up to date, 30th November, 1891, it will be seen that this great mine bids fair to rival, if not surpass, the famous Comstock lode of the Pacific slope. The net profits for the half year ending 30th November, 1891, amounted to £633,737 10s. 8d., of which £576,000 was paid in dividends. The total dividends and bonuses to the above date amounted to £3,896,000. The total quantity of ore treated being 803,497½ tons, yielding 30,757,505 ounces of silver, 125,102¼ tons of lead. Net amount realized, £7,059,175 13s. 5d.

The company's plant consists of fifteen 80-ton smelters, also very complete concentrating, leaching, and refining works, the latter at Port Pirie. An agreement has been made with the Tarrowingee Flux Company by which a regular supply of valuable limestone flux is obtained at a saving to the proprietary of at least £30,000 per annum.

A supply of water has been secured from the Acacia Valley in connection with British blocks, Block 14 and Block 10 companies, who have together formed a trust for the conservation and regulation of the water supply from that source. A 6-inch service pipe with adequate pumping machinery has been laid down to connect with the mine mentioned. The storage capacity of the proprietary reservoirs and dams equals 15,000,000 gallons.

Arrangements have been made by the Proprietary Company for the practical testing by boring of the country lying between Broken Hill and Menindie for artesian-water supply, as advised by Mr. Geological Surveyor Anderson and Mr. Dixon, of Adelaide.

The outcrop of the Broken Hill lode in the Proprietary Company's ground is being quarried by contract, and vast quantities of good grade ore and ironstone flux obtained at a small hewing cost. The removal of the vast ironstone capping is also likely to relieve the strain on the mine timbers. Not a little difficulty is likely to be experienced in keeping open such a huge fissure when the ore body is removed, the average width of the lode being not less than 50 feet, and in some parts it exceeds 200 feet in width.

At the Broken Hill Proprietary Block 10 Mine, the work of exploration and development was vigorously carried on during the half year ending 31st March, 1892. Shafts and winzes were sunk, and levels and crosscuts driven to the extent of 1,428½ feet. Important and extensive surface works were also constructed, the greatest depth attained being 633 feet; the lower 106 feet was sunk during the half year ending

31st March, 1892; the whole in sulphide ore averaging 23 ounces of silver, 20 per cent of lead, and 23 per cent of zinc.

During developmental exploration 32,000 tons of sulphide ore have been raised to the surface, the average yield of which is estimated by careful assays to be 34.88 ounces of silver, 22 per cent of lead, and 28.87 per cent of zinc.

The total dividends paid to date, 31st March, 1892, amount to £360,000.

The cost of treatment, including mine wages, smelting charges, railway, and all other incidental expenditure, amounted to £7 6s. 10d. per ton of ore.

The Broken Hill Proprietary Block 14 Company suffered, in common with the other principal mines in this district, on account of scarcity of water for smelting and dressing purposes. Nothwithstanding this drawback, however, substantial progress has been made and fair dividends paid. The difficulty as regards a supply of water has been practically overcome, an arrangement having been mutually arrived at between the principal Broken Hill mines for a supply of water from the Acacia lime beds, about 10 miles distant, by means of iron pipes.

The company has recently leased the Broken Hill Junction smelting works at Port Adelaide. The two furnaces at these works and the three at the mine are capable of treating about 1,400 tons of ore per week; a fourth furnace is in course of construction at the mine.

The greatest depth attained in this mine to the end of March, 1892, was 500 feet, 584 men being employed in the mine and works. The cost of smelting amounted to £2 6s. 9½d. per ton of ore. The dividends during the half year amounted to £52,500, making a grand total, since the commencement of smelting in October, 1891, of £195,000.

The following analysis of sulphide ore from the 400-foot level in the main shaft is of interest as showing the character of the ore which prevails throughout the whole course of the Broken Hill lode below the water level. The services of Professor Schnabel (an eminent German metallurgical expert) have been obtained for a term, on behalf of the mines on the lode, for the purpose of experimenting and reporting on the best method of treatment of ores of the character here indicated:

	Per cent.		Per cent.
Zinc	23.30	Manganese traces	1.00
Iron	7.40	Lime	1.20
Lead	28.20	Alumina	
Copper	1.20	Antimony	.50
Sulphur	21.50	Arsenic	1.00
Insoluble residue	13.95	Moisture	.10
Silver—26.2 ounces per ton	.07	Losses	.58

At the Central Broken Hill Silver Mine, during the half year ending 31st December, 1891, the production amounted to 899,239 ounces of

silver, 1,887 tons of lead, and 197 tons of copper, equaling an average per ton of 40.16 ounces of silver, 8.47 per cent of lead, and 0.88 per cent of copper.

During the same period £71,250 were paid in dividends.

In common with the other mines on the Broken Hill lode, the Central Mine suffered from want of water, which not only precluded the five smelters being kept in full work, but also seriously affected the water jackets. The metallic salts in solution in the water becoming concentrated from constant usage corroded the jackets.

At the Broken Hill south mine during the half year ending 31st December, 1891, the total receipts were £130,866, while the expenditure amounted to £124,751, so that notwithstanding the large amount of developmental work performed, this mine has been self-supporting. The production for the year was 623,458 ounces of silver and 1,531 tons of lead, the average yield being 40.17 ounces of silver per ton and 8.7 per cent of lead. The greatest depth attained is 632 feet. Exploration and development have been pushed on, and good progress made. The surface works are of a most substantial and permanent character, including haulage plants, two 80-ton smelters, tanks and dams, and tramway to connect with Silverton tramway line. It is satisfactory to note that the chief cost of these important developments is defrayed from the proceeds of sale of ore raised during the prosecution of the work.

The British Broken Hill Proprietary Company have had to contend with an extensive fall of ground, which caused a considerable expenditure of time and capital to reopen and secure, and only recently has it been possible to resume work in the region affected. In the last report placed before the shareholders in November, 1891, it was stated that a valuable discovery of lead-bearing ironstone, very suitable for fluxing, had been made on the company's property, thus saving the necessity of purchasing ironstone flux.

A market has been found in the colony for a fair quantity of carbonate of lead ore, which, though rich in lead, is poor in silver.

A new type of furnace devised by the general manager has been found very suitable. Owing to the realization charges for low-grade bullion being very high it has been found advantageous to enrich the company's bullion by the purchase of small quantities of rich ore from the Proprietary mine to smelt with the poorer lead ores from the company's mine.

At the Broken Hill north mine a concentration plant, capable of treating 90 tons of ore per day, has been erected. At the Australian Broken Hill Consols mine two very valuable discoveries of rich ore have recently been made, large masses of chloride and native silver being obtained in a solid state.

A considerable quantity of ore has been raised from many other mines

in this and the Silverton districts. The following export is recorded for 1891 for the districts mentioned: Silver-lead bullion, 54,722 tons, valued at £2,539,685; silver-lead ore, 93,942 tons, valued at £985, 408; copper ore, 203 tons, value, £3,955. Total value, £3,529,043.

The Sunny Corner lode, which occurs in altered Silurian rocks intruded by elvanite, was originally worked for gold in 1875. The argentiferous nature of the lode stuff was demonstrated by Mr. H. Y. L. Brown, geological surveyor, who, in 1881, inspected and reported on the mine. (See annual report, Department of Mines, 1881.) The oxidized ores consisted of porous silicious gossan and stalactitic brown iron ore; nests of native silver were occasionally visible in the cavities of the gossan. Below the water level the ore changed into a refractory mixture of sulphides of iron, copper, lead, and zinc. The matter produced during 1890 was valued at £72,642 17s. 9d. During the year 1890, 35,287 tons of ore were raised; 39,046 tons were treated, producing 404,006 ounces of silver, 344 tons of copper, 4,048 ounces of gold, and 25 tons of lead, of a total estimated value of £104,565.

At the old Nevada mine, 1,700 tons of ore were raised, of which 1,020 tons were sent to Lithgow for treatment, and 680 tons were smelted at the mine, producing 110 tons of matte, valued at £3,080.

The principal argentiferous lode opened in the New England district in 1884 was that of the Webb's mine, about 7 miles northwest of Emmaville. The rocks in which the lode occurs are described by Mr. T. W. E. Davis, B. A., F. G. S., as altered Palæozoic clay stones and mud stones, in some places passing into argillites. The lode stuff is brecciated, and composed chiefly of slate rock, with strings and bunches of quartz; the metalliferous contents consist chiefly of galena, mispickel, copper pyrites, and argentiferous tetrahedrite. During 1891 the ore raised, hand picked, and machine dressed, yielded 354 tons of concentrates, assaying 85 ounces per ton.

Mount Galena, a new discovery on a parallel lode to the latter mine, gives very favorable promise of payable developments; 190 tons of picked ore was sent away for reduction during 1891.

At Borah Creek, near Inverell, a payable deposit of silver-lead ore has recently been opened, and other claims in the locality are being vigorously prospected.

Webb's Consols, Castlerag, Castle King, Castle Wellington, and Pyes Creek mines are all more or less argentiferous lead lodes of varying richness and permanency from which considerable quantities of ore will be raised.

At Wollomombi rich silver-sulphide ore in quartz veinstone has been recently discovered, and preparations are being made to develop the mine.

At the White Rock silver mine, about 3 miles from Fairfield, the large and expensive plant, erected at great cost, proved unsuitable.

At the present time the mine and works are practically shut down. From the fact, however, that the concentrates are rich in silver, and that unlimited quantities of ore can be readily quarried from the exposed face, containing a fair proportion of concentrates, there can be little doubt that, with more efficient treatment, this mine will yet prove payable. A trial parcel of 10 tons of this ore has recently been treated by the Lührig concentrator, under the supervision of Mr. Cosmo Newberry, C. M. G., with very satisfactory results.

At Rivertree, New England, sulphides of silver occur, and a leaching plant is being erected as most suitable for the extraction of silver.

The Mount Costigan mine is situated at Tuena, county of Georgina. Smelting was commenced in two furnaces in July, 1887, and 4,565 tons of ore were treated, yielding 106,084 ounces of silver, 659 ounces of gold, and 359 tons of lead, of a total value of £26,361. Here, as at the Cordillera Hill and Peelwood mines, in the vicinity; the New Lewis Ponds mine, near Orange; the Sunny Corner mine, in the Bathurst district, at Captain's Flat, and, in fact, in many other mines within the colony, below the water level the ore changes in its character from easily worked plumbiferous gossany ores to refractory sulphides, in which zinc sulphide largely abounds. Hence there is a great future in store for the discoverer of a suitable economic process for concentrating and treating such ores; in fact, the permanency of silver mining depends upon such a discovery, especially that of efficient concentrating machinery.

It is probable that the Mount Costigan will shortly be again opened.

It was earnestly hoped that some practical results would follow the investigations of the eminent German metallurgist, Dr. Schnabel, of the character and most advantageous method of treatment of the Broken Hill sulphide ores from below water level. The pith of his lengthy report is that these ores—sulphides of lead and zinc in about equal proportions—can only be treated with profit at the seaboard, a double treatment being necessary, roasting and leaching to remove the zinc, and smelting of the residuum for silver-lead bullion. There is no doubt as regards richness and quantity; the Broken Hill sulphide deposits compare more than favorably with profitably worked continental deposits of similar character, the great drawbacks to highly profitable working in New South Wales being the price and uncertainty of labor, excessive cost of fuel, and distance from seaboard.

At the Mount Stewart silver mine, Leadville, an 80-ton water-jacket smelter has been erected, and the large amount of ore raised during the prospecting operations, which have been systematically carried on for a considerable period, is now being profitably smelted.

The Commodore Vanderbilt Company, at Captain's Flat, smelted 5,657 tons of gossan ore, producing 63,750 ounces of silver, 86 tons of lead, and 802 ounces of gold.

A considerable amount of systematic prospecting has been done on the Wallah Wallah silver lode in the Burrowa district, and payable ore has been proved in several shafts on the course of the lode; at the lowest depth reached the ore was improving in value.

A very rich argentiferous bismuth ore has recently been discovered at Whipstick, near Pambula.

There were some forty or more exhibitors of representative collections from some of the leading mines of the colony. The ministry of mines for New South Wales and for Sydney sent large and well-arranged collections of hundreds of specimens. Many of these were specially interesting as illustrating the frequent occurrence of gold in feldspathic lode stuff, and also in close association with stibnite—sulphide of antimony. This unusual association occurs at the Eleanora Gold and Antimony Mine Hill Grove, at which the average yield is stated to be about 1 ounce of fine gold per ton.

The Eleanora Gold and Antimony Mining Company, George Smith, manager, Hillgrove, near Armidale, exhibited auriferous quartz and sulphide of antimony, with white metal, crude and granulated antimony, from the Eleanora gold and antimony mine, near Hillgrove. The quartz veinstone is from a 12-foot reef at the 400-foot level. Since the commencement of this mine 42,000 tons of stone have been crushed. In addition, 2,000 tons of sulphide of antimony and 150 tons of white metal were sent to the London market. The average yield was about 7 pennyweights, the loss being considerable, owing to the presence of antimony. A new and more profitable process of extraction has, however, been discovered, which is expected to materially increase the average yield of gold.

Garibaldi Gold-Mining Company (Limited), 19 Post-Office Chambers, Pitt street, Sydney, sent a similar exhibit of 5 tons of auriferous antimonial quartz veinstone from Garibaldi mine, Hillgrove. The mine is situated at Hillgrove, in the New England district, and comprises an area of about 40 acres, held under gold lease. The workings consist of 3 shafts sunk on the line of reef. No. 1 (main shaft) has been sunk 200 feet. The shaft is timbered all through and divided into 3 compartments for haulage and ladder way. Levels have been put in at the 100-foot and driven north 125 feet and south 200 feet, and at the 200-foot driven north 115 feet. A winze has been sunk between these levels and an intermediate level opened up and driven north and south. The reef in this shaft varies a good deal in thickness. Above the 100-foot level it is 20 feet thick, and carries a little gold and antimony in veins or stringers throughout. At the lower levels the reef is more confined, being about 4 feet thick, and the antimony is found in veins of about 8 to 10 inches thick in the reef.

No. 2 shaft has been sunk 142 feet; levels opened out at 50 feet, 100 feet, and 142 feet. The reef here varies from 12 inches to 3 feet

and is richer in gold. Some patches have given as high as 5 ounces per ton; the average will be about 1 ounce to 25 pennyweights. The battery consists of 20 head of stampers and has adjuncts—2 rock breakers, 4 Frue vanners, 10 Berdan pans, 4 Chillian mills. The latter have been found useless for the class of stone and are abandoned.

It was found impossible to save the gold by ordinary amalgamation, as the antimony sickens the quicksilver and the gold floats away. The company now smelt all antimonial ore in a furnace, and after the antimony is smelted or "sweated" out of the stone it is found more easily treated at the battery. The company have recently erected a retort, a patent of Messrs. Warren & Mansfields, of Melbourne, who maintained they could drive off all the antimony in the shape of an oxide by hot-air blast, and collect it in flues, and leave the stone with the gold free, but up to the present it has not been a success. This is the great difficulty the company have to contend with, that they can not save a fair proportion of the gold known to be in the stone, and crushings show that about 4 or 5 pennyweights are saved, and from 9 to 15, and even 20 pennyweights, are lost in the tailings.

If some process could be discovered to drive off all the antimony and save it in the shape of an oxide, so that the free gold would be left to amalgamate, the mine would pay good dividends.

GOLD NUGGETS.

Among the other interesting specimens forwarded by the minister of mines and agriculture, Sydney, to illustrate the formation of auriferous deposits, rhinestones, and lode stuffs of the gold fields of New South Wales there was a small but valuable series of rich specimens of alluvial and reef gold, as follows: The Maitland Bar nugget, Hargraves, weight, 344.78 ounces, containing 313.093 ounces of fine gold according to specific gravity test, value £1,236 14s. 1d; gold in ferruginous quartz, Lucky Hit Find gold mine, Apple-tree flat, gross weight, 21.49 ounces, specific gravity, 7.11; fine gold, 14.85 ounce, value £57 10s. 9d. Nugget of gold from Wood's Flat, near Cowra—weight, 42 ounces 17 pennyweights, 5 grains; value, £168 5s. 5d. Gold in quartz from Mother Shipton reef, Temora, depth, 90 feet from surface. This specimen is estimated by specific-gravity test to contain 258.33 ounces of gold; value, £1,033. Gold in quartz from Mother Shipton reef, Temora, estimated to contain 41.53 ounces of gold, value, £146.

Fineness of New South Wales placer gold.

[Samples of alluvial gold from the undermentioned gold fields of New South Wales. Assayed at the royal mint, Sydney.]

No. of specimen.	Locality.	Specific gravity.	Loss per cent in melting.	Assay report.		Gross value per ounce.
				Gold in 10,000 parts.	Silver in 1,000 parts.	£ s. d.
1	Tenterfield	15.89	2.733	8905	100	3 13 11
2	Mudgee	16.89	1.713	9370	055	3 18 5
3	Tibooburra	18.33	.423	9735	020	4 2 4
4	Uralla	17.76	1.215	9560	040	4 0 3
5	Tumbarumba	15.98	2.955	9460	045	3 18 1
6	Bathurst	16.78	2.033	8865	080	3 14 0
7	Forbes	15.47	2.647	9215	075	3 16 5
8	Hill End	16.44	2.663	9445	045	3 18 2
9	Sofala	16.71	1.848	9265	070	3 17 5
10	Kiandra	15.15	3.115	9240	070	3 16 3
11	Nundle	15.00	2.642	9220	070	3 16 5
12	Bingera	14.54	5.137	8995	090	3 12 9
13	Tamworth	15.94	1.716	9355	060	3 18 3
14	Copeland	14.69	3.748	9000	090	3 13 10
15	Nerrigundah	17.75	1.395	9825	010	4 2 4
16	Murrumburrah	17.06	1.906	9470	045	3 19 0
17	Glen Innes	17.19	1.535	9435	060	3 19 0
18	Ironbarks	16.29	2.420	9420	055	3 18 3
19	Orange	16.29	2.188	9290	065	3 17 5
20	Windeyer	18.39	.995	9550	040	4 0 5
21	Temora	16.71	2.166	9575	030	3 19 7
22	Rocky River	16.70	1.423	8760	115	3 13 9
23	Adelong	17.18	1.958	9470	045	3 19 0
24	Tambaroora	17.10	1.522	9835	060	3 18 3
25	Braidwood	16.73	2.330	9455	045	3 18 7
26	Tenterfield	.....	.....	8520	135	3 10 5
27	Milparinka	.....	.....	9715	015	3 19 2
28	Tibooburra	.....	.....	9725	020	4 1 11
29	Nerrigundah	.....	.....	9880	010	4 2 1
30	Bingera	.....	.....	8970	095	3 13 7
31	Young	.....	.....	9605	030	4 0 0
32	Temora	.....	.....	9580	030	3 18 2
33	Adelong	.....	.....	9465	045	3 18 1
34	Mudgee	.....	.....	9470	045	3 19 6
35	Armidale	.....	.....	9085	085	3 16 2
36	Tambaroora	.....	.....	9440	050	3 19 4
37	Ironbarks	.....	.....	9665	030	3 19 0
38	Kiandra	.....	.....	9200	070	3 16 1
39	Sofala	.....	.....	9270	070	3 17 6
40	Tamworth	.....	.....	9235	065	3 14 11
41	Barraba	.....	.....	9020	090	3 11 9
42	Glen Innes	.....	.....	9535	040	3 18 7
43	Stony Creek	.....	.....	9135	080	3 16 8
44	Tumbarumba	.....	.....	9190	070	3 15 7
45	Bowling Alley Point, Peel River (3 specimens), crystallized gold	.....	.....	.....	.....	.....
46	Old Potato Ground, Burrandong, crystallized gold	.....	.....	.....	.....	.....
47	Williams' Lease, The Peak, detrital gold	.....	.....	.....	.....	.....

PLATINUM.

Platinum in small grains has been found occasionally in the gold drifts in various parts of New South Wales. Its occurrence in the beach sand on the north coast, between the Richmond and the Tweed, has been known for many years. Fine gold occurs associated with it in the black sand on the coast. Beach working for gold has been carried on at intervals for a long period, especially after easterly gales. In the ordinary miners' cradles, with which the gold is obtained, a small quantity of platinum collects from time to time on the blankets, but no efficient means are at present known for saving the platinum on a large scale. Possibly the great advance in value of platinum

will lead to practical efforts being made to work these platiniferous and auriferous beach sands, which occur in large quantity.

The black beach sand consists chiefly of titanic iron, colored and colorless zircons, and sometimes a little tin. The platinum particles being excessively small, sizing will be necessary before concentration is attempted.

Recently, and for the first time in the colony, platinum has been discovered in a lode formation, viz, near Broken Hill. Assays have revealed its presence up to 1 ounce per ton in the lode stuff.

Investigations as to the character and yield of the ores of this deposit have lately been carried out in Europe, Adelaide, Melbourne, and in the laboratory of the department of mines, Sydney, the general opinion being that the platinum occurs in a very fine state of division and in too small a quantity to be worked with profit.

Traces of platinum have also been found in the Parkes and Orange districts, and in small quantity associated with the auriferous drifts in the Mudgee and Shoalhaven districts.

SILVER AND LEAD.

Under the head of silver and lead there were numerous exhibitors, besides the large collections from various localities and mines in New South Wales sent by the minister of mines and agriculture.

Various lodes have been found in various parts of New South Wales. Previous to the year 1884 the mines at Boorook were the principal ones worked. The value of the silver produced in the colony during 1883 amounted to £18,563; but in 1884 the argentiferous lead lodes of the Silverton district, in the Barrier ranges, near the western boundary of the colony, were opened, and from them during 1885 silver and silver-lead ore to the value of £108,281 was exported. Since May, 1886, to May 31, 1892, 36,512,445 ounces of fine silver have been obtained from the Broken Hill Proprietary silver mine in this district. During 1885 the quantity of ore furnaced at the Sunny Corner mine, in the Bathurst district, was 24,547 tons, producing 634,016 ounces of silver and 6,413 ounces of gold. Several lodes containing rich silver ore, chiefly fahlerz, associated with galena and blende, occur in the Vegetable Creek district; other lodes occur near Orange, Captain's Flat, Castle Rag, Goulburn, etc. The value of the silver, silver lead, and silver-lead ore produced in New South Wales up to December 31, 1891, amounted to £11,302,095.

The following notice of the leading mines of the famous Broken Hill region, in the Barrier range, is from the statement by the company in the official catalogue:

The late Mr. C. S. Wilkinson, Government geologist of New South Wales, visited the Barrier range silver field early in 1884, shortly after the rush to the field. Writing of Broken Hill, which at the time had only been prospected to the extent of two

shallow shafts, he states as follows: "About 3 miles to the southwest is the Broken Hill, so called from the rugged outline of its rocky summit. This hill is the highest point on a narrow ridge which runs northeast and southwest for several miles, and forms a conspicuous feature in the district, rising for about 150 feet above the general level of the undulating plain country on each side. The crest of the ridge is formed by the outcropping of a huge lode. The lode varies in width from 10 to 120 feet, and in places rises above the surface in large craggy black masses. It changes in character every few feet, and consists of ferruginous quartzite, quartz, griesen, feldspar, porous brown iron ores or gossan, and oxide of manganese (pyrolusite), with patches and veins of crystallized carbonate of lead (cerussite). The occasional black color of the mass is due to the manganese oxide. Two shafts, one 52 feet and the other 50 feet deep and about 30 chains apart, have been sunk into the lode, as well as two smaller shafts between these. * * * Further prospecting will, I am of opinion, prove this to be a valuable argentiferous lead lode. It appears to dip with the strata, about N. 40° W. at 50°, and on the northwest side sends off several branches. About 10 chains from it there is a large dyke of diorite." Visiting Broken Hill again in 1887, Mr. Wilkinson states: "It is a true fissure lode, varying from 10 to 160 feet wide, and consists chiefly of porous iron and manganese oxide in places more or less silicious, containing carbonate of lead and chloride of silver, with occasionally carbonates of copper and zinc. The walls of the lode are well defined, especially the hanging wall, which in two places I measured dips to the N. W. 65°, but the dip varies in places, and has changed to the east, below the 217-foot level in McCullock's shaft. I noticed that one projection on the hanging wall had been rounded and striated by a faulting or downward sliding movement northerly at an angle of 47°. This is an important feature, showing that, though the lode must necessarily vary in width, it will continue as far as the displacement or sliding movement of the hanging wall has taken place, probably to a great depth. The lode continues northerly with much the same character, narrowing and widening in places through blocks 14, 15, and 16, and Broken Hill Junction, beyond which it seems to continue in irregular smaller lodes of a more silicious nature, containing argentiferous galena and carbonate of lead and copper, with a little chloride of silver. To the south it passes into quartzite lodes, containing silver, lead, and copper ores, sparingly distributed through the lode stuff."

In April last (1892) Mr. E. F. Pittman, the present Government geologist, furnished a report in which he stated his opinion that in its mode of occurrence the Broken Hill lode is analogous to the celebrated Saddle lodes of Bendigo, Victoria. He states that the lode occupies a fissure in the anticlinal fold of which Broken Hill is formed, and that at a depth which varies in the different mines along the hill it divides into two portions or legs, one following the eastern dip, while the other and larger portion dips to the west. Mr. Pittman is of opinion that these legs will be found to thin out as they descend, but that there is a possibility of other saddle lodes being formed more or less vertically under the present one, and in order to test this he recommends that diamond drill bores be put down through the cap of what is locally known as the "intrusion," but which, he states, is merely the cap of an anticline of gneiss rock underneath the lode.

At the time of the last half-yearly report (May 31, 1892), 3,203 men were employed in connection with this mine; of this number 1,686 were employed underground.

Dividends and bonuses, the latter derived from the flotation of offshoot companies, up to the date above mentioned amounted to £6,216,000, equal to £5 3s. 4½d. per 8-shilling share on 800,000, colonial register, and £2 2s. per 8-shilling share on 160,000, London register, or £279 10s. per share on the original £20 shares, which were issued as paid up to £9.

The above vast amount has been realized since smelting was commenced in May, 1886.

The smelting plant now consists of fifteen 60-inch by 112-inch water-jacket fur-

naces. During the half year the furnaces averaged 49½ tons each per twenty-four hours while in blast. The average is lower than that of the previous half year, owing to scarcity of water necessitating the raising of highly mineralized water.

The lixiviation (leaching) plant was only in operation for thirty-four weeks during the half year, and then only to a quarter of its capacity. A total of 14,802 tons of concentrated tailings and roasted ore were treated, producing 71,737 ounces of silver, the cost of treating tailings being 6s. 1d. per ton.

Experimental work has been done with the roasting plant, the material being low-grade kaolin and dry silicious ores, carrying from 20 to 34 ounces of silver per ton. The extraction varied from 62 to 87 per cent. The best results were obtained when the furnace was treating about 35 tons of ore per day, the extraction reaching from 85 to 87 per cent. The loss in volatilization was extremely small, the cost of experimental works of crushing, roasting, and leaching being 21s. 8d. per ton.

At the refinery at Port Pirie the cost of refining silver from the lead bullion amounted to £1 14s. 6.31d. per ton of bullion.

During the year ending May 31, 1892, the following classes and quantities of ore were treated:

Lead ore	126,692 tons,	or 51.5 per cent of total.
Silicious iron ore and kaolin	116,742 tons,	or 47.0 per cent of total.
Iron ore	3,473 tons,	or 1.5 per cent of total.
Total	246,907	

Consumption of fuel and fluxes:

Coke	44,452 tons,	or 18.0 per cent of the ore treated.
Coal	7,057 tons,	or 2.8 per cent of the ore treated.
Limestone	79,241 tons,	or 32.0 per cent of the ore treated.
Ironstone	7,750 tons,	or 3.1 per cent of the ore treated.

The cost of smelting amounted to £1 14s. 9d. per ton of ore.

Working summary, showing gross quantities and values of produce, with net cost and net profit per ton of ore treated, for each half year from November 30, 1885, to May 31, 1892.

Half year ending—	Ore treated.				Silver produced.	Lead produced.				Net amount received.			Value per ton of ore treated.		
	Tons.	*cwt.*	*qr.*	*lb.*	*Ounces.*	*Tons.*	*cwt.*	*qr.*	*lb.*	£	*s.*	*d.*	£	*s.*	*d.*
Nov. 30, 1885	48	0	0	0	35,605	.....				7,442	12	11	.....		
May 31, 1886	1,103	0	0	0	144,604	.....				37,053	5	2	.....		
Nov. 30, 1886	10,397	0	2	0	871,665	1,990	17	3	0	157,215	9	0	15	2	5
May 31, 1887	18,410	16	3	0	835,526	2,836	7	1	0	204,559	0	7	11	2	2
Nov. 30, 1887	28,799	18	0	25	1,267,699	6,511	13	3	11	287,704	15	6	9	19	6
May 31, 1888	39,789	8	3	26	1,633,737	6,773	19	2	15	373,034	16	4	9	7	6
Nov. 30, 1888	54,336	0	2	6	2,290,455	9,885	10	2	23	512,367	1	10	9	8	7
May 31, 1889	68,545	4	2	13	2,677,686	11,417	10	0	12	586,897	12	8	8	11	0
Nov. 30, 1889	88,639	0	0	0	3,325,613	13,659	4	0	15	744,931	1	10	8	8	1
May 31, 1890	103,399	0	0	0	3,855,331	15,399	14	2	27	872,758	1	8	8	8	9
Nov. 30, 1890	103,912	0	0	0	3,872,546	14,938	19	0	22	974,758	13	6	9	7	7
May 31, 1891	138,645	0	0	0	4,918,124	24,222	12	1	9	1,135,569	17	3	8	3	9
Nov. 30, 1891	147,473	0	0	0	5,028,914	17,465	15	1	9	1,165,883	5	2	7	18	1
May 31, 1892	180,852	0	0	0	5,754,940	26,843	10	2	27	1,192,962	13	1	6	11	11
Total	984,349	9	2	14	36,512,445	151,945	15	3	2	8,252,138	6	6	.....		

Working summary, showing gross quantities and values of produce, with net cost and net profit per ton of ore treated, for each half year from November 30, 1885, to May 31, 1892—Continued.

Half year ending—	Total expenses, including depreciation. a	Average cost per ton of ore treated.	Profit per ton of ore treated.	Disbursement of profits, less balances and stocks in hand.		
				Dividends and bonus.	Depreciation.	Construction.
	£ s. d.	£ s. d.	£ s. d.	£	£ s. d.	£ s. d.
Nov. 30, 1885 .	4,644 15 4	.....	.....	.....	.....	2,582 15 11
May 31, 1886..	24,199 3 8	.....	.....	.....	.....	18,737 8 8
Nov. 30, 1886 .	70,345 10 6	6 15 4	8 7 1	47,000	.....	10,612 9 5
May 31, 1887..	121,921 2 2	6 12 5	4 9 9	80,000	5,060 1 10	19,701 18 2
Nov. 30, 1887 .	167,503 10 1	5 16 4	4 3 2	96,000	7,945 3 7	35,361 10 6
May 31, 1888..	179,799 9 4	4 10 5	4 17 1	152,000	9,876 13 8	49,479 16 10
Nov. 30, 1888 .	237,968 4 1	4 7 7	5 1 0	192,000	11,788 6 5	37,665 14 7
May 31, 1889..	293,172 4 10	4 5 7	4 5 5	240,000	13,475 1 1	54,337 2 6
Nov. 30, 1889 .	335,575 19 1	3 15 9	4 12 4	368,000	40,617 15 4	42,959 13 2
May 31, 1890..	403,480 1 2	3 18 0	4 10 9	464,000	45,594 8 7	44,827 3 11
Nov. 30, 1890 .	445,492 17 6	4 5 9	5 1 10	528,000	22,809 2 4	46,183 2 7
May 31, 1891..	544,713 10 8	3 18 7	4 5 2	576,000	22,526 7 5	19,980 15 2
Nov. 30, 1891 .	532,145 14 6	3 12 2	4 5 11	576,000	24,845 9 6	45,718 9 3
May 31, 1892..	670,179 15 0	3 14 1	2 17 10	576,000	26,678 6 11	43,174 0 8
Total ..	4,031,141 17 11	.....	.....	3,896,000	231,216 16 8	471,322 1 4
Less depreciation						231,216 16 8
Balance construction, as per balance sheet						240,105 4 8

a Irrespective of London realization charges.

BELGIUM.

The Société générale de traitement des minerais d'or, d'argent et autres, Bruxelles, 91, Boulevard du Nord, exhibited samples of raw auriferous sulphurets containing arsenic, antimony, and tellurium, known as refractory or rebellious ores, with illustrative samples of the same ores and products treated by a new process, known as Body's, of which no further information has been received.

GOLD IN GRANITE AND ALLIED ROCKS.

In the representative series of gold specimens and ores sent by the minister of mines and agriculture from New South Wales to the Columbian Exposition in Chicago, in 1893, there were numerous specimens from granitic and feldspathic lode stuff. Nos. 10, 11, and 12 of the collection were from "binary granite." No. 10 contained gold associated with copper pyrites and iron pyrites from the Challenger mine, Adelong. No. 11 was from the 978-foot level of the great Victoria mine, and No. 12 from the 770-foot level of the same mine.

A pyritous granite was shown from Dargués Reef, Majors Creek, Braidwood. This auriferous stuff is described as 25 feet in width at the 225-foot level. Nos. 23, 24, 25, and 27 of the same collection consisted of auriferous feldspathic lode stuff, showing some free gold from different mines at Galnal. Feldspathic lode stuff, with mispickel and oxidized pyrites, is found also at the Junction Reef, Mandurama. Auriferous quartz and feldspathic veinstone, rich in gold, occurs in the Hill End district and at Delaneys Dyke, near Molong.

In the collection from Sydney there were gold-bearing specimens with feldspathic gangue from Sawpit Gully, Fairfield. Three mines at Timbarra were represented by masses of auriferous granite. The feldspathic gangue occurs in some places in a brecciated condition. At Wanns lode, Drake, New England (No. 140), the gold is obtained from a siliceous feldspathic breccia. At the Mount Graham gold mine, Pambula, the occurrence of the gold is described as "unlike anything hitherto discovered in any of the colonies. The lodes are, in the main, conglomerates and feldsitic breccias, in many instances only to be distinguished from the country by irregular walls. The gold is extremely fine and difficult to follow. Frequently there is nothing to distinguish the gold-bearing from the barren stone. The drillings and the mortar are the only sure guides.

It should be incidentally mentioned that specimens of vesicular and amygdaloidal basalt were shown from Black Rock, Ballina, and claimed to be auriferous.

GOVERNMENT AND LAW.

BY

Dr. RICHARD HIRSCH, Judge.

GOVERNMENT AND LAW.

By Dr. RICHARD HIRSCH, *Judge.*

Government and law is not readily susceptible of being brought before the eyes of the visitor. Nevertheless the United States have gathered in the Government building a collection of the highest interest from a political and a historical standpoint, a collection which can not be excelled for perspicuity and practical demonstration. In most of the departments we find novel and practical arrangements, especially in the census department, which has exhibited the very useful Hollerith electric-tabulating system and shows how it is operated. The statistics given in the United States Government building are of the highest interest for completeness and practicability, and treat nearly all important political and commercial questions.

In the anthropological department most of the States have shown how their prisons are conducted, and the work done by some of them is worthy of the highest admiration. The prison for men in Elmira, N. Y., and the prison for women in Sherborn, Mass., are two model institutions, unsurpassed by any in the world.

For sanitary arrangements and good ventilation the Western Penitentiary, in Allegheny, Pa., is a most instructive example and worthy of imitation. For reform schools the work of the Lyman school, in Westboro, Mass., of the New York school, in Westchester, and of the State industrial school for girls at Lancaster, Mass., show perhaps the highest and best development of the juvenile reformatory system in America. The Massachusetts work is under the cottage plan (25 or 30 to a home). The New York school at Westchester is under the congregate plan. All of them show a remarkable care for the individual training of their inmates, much attention being given to manual training.

I can not fail to notice that this exhibit also is provided with excellent statistics, most of them being given on practically arranged cards. Of the foreign countries, Japan, Mexico, Russia, Spain, and New South Wales have shown some examples of their government and law, especially of their prisons.

GENERAL REMARKS.

The department of the Exposition that treats of the commercial and social problems and questions of religion, charity, and cooperative works had to contend with many and great difficulties. Just as in human life, these questions penetrate all conditions, and as it is difficult to place them by themselves, crystallized and separated from the individual circumstances to which they are attached, so also the Exposition has no department in which these questions are especially demonstrated. The only country which has given a social exhibit, containing all branches, that can be considered as a very excellent one, namely, the French Republic, has withdrawn from competition. Under these circumstances this splendid and highly instructive exhibit is no more to be considered. The exhibits of the other countries are unfortunately widely scattered. From the Philadelphia workman's house on Midway Plaisance to the anthropological building, which contains a great number of important and original objects, almost every building has something of value for this report. The principal exhibits are to be found on the second floor of the manufactures' and liberal arts building and in the anthropological building.

One's impression suffers greatly through the unfavorable locations, and, what is worse, sometimes the separation into classes has not been quite advantageous, but what I find of the greatest disadvantage is that a full catalogue of the department, of which I will give a brief sketch, has not appeared. I have treated the exhibits by groups or classes according to their importance.

GROUP 154.—COMMERCE, TRADE, AND BANKING.

Class 895, history and statistics of trade and commerce.—I am highly pleased to notice on this occasion the excellence of the publications of the United States and the liberality with which they are dispensed to all who are interested. Especially meritorious are the United States consular reports, which are highly esteemed in all countries, and the brief, practical, and almost indispensable statistical abstract, prepared by the Bureau of Statistics under the direction of the Secretary of the Treasury. Also some of the State publications are quite remarkable. Of the foreign countries, Japan and New South Wales are uppermost. Both of these have published in honor of the Exposition quite a library of well-edited and instructive works, which will not fail to bring new friends to these highly civilized and progressive countries, new customers for their natural resources, and open new avenues to their commerce.

Mexico has also edited for the Exposition a valuable publication: "Mexico, its trade, industries, and resources, by Antonio Garcia Cubas,

translated by W. Thompson." Other States have treated special questions; for instance, the Saxon textile industry has published an interesting little report, and naturally publications of great extent are only required from States which are at a disadvantage through poor communications or through the novelty of their culture.

Concerning communication we find many highly interesting exhibits at the Exposition. Of the greatest interest is the exhibit of The Bureau of the American Republics, illustrating the resources, customs, industries, and commerce of Mexico, Central and South America, and the West Indies. I can not fail to mention the excellence and accuracy of the special Exposition bulletin ("How the Latin American Markets May be Reached by the Manufacturers of the United States," Bulletin 63, Bureau of the American Republics, Washington, U. S. A., 1893) and of the maps, especially the relief map of Central and South America, showing the proposed line of the intercontinental railway and existing railways and steamship lines. Also the relief map of the Nicaragua Canal, which is to be found in the transportation building, brings to view the constant desire for a nearer alliance between the United States and the South American countries.

Altogether the Exposition demonstrates that the governments have returned from the error of considering railways superior to waterways, and we notice with pleasure the beautiful exhibit of the canal system of the State of New York and the various and comprehensive canal projects of the German Empire.

Class 896 (railway and transportation companies) has undoubtedly found a full appreciation from another point of view in the report of the judges of transportation. Here we have only to give a brief sketch from the historical and economical standpoint. Of the first importance are the excellent historical exhibits of the Baltimore and Ohio and of the Pennsylvania Railroad; further, the history of the development of railway track, given by the Georgs- und Marien-Bergwerks- und Hüttenverein, of Osnabrück (Germany).

Interesting and practical is the Mexican exhibition, showing the resources, beauties, and curiosities of the country. The Mexican Central Railroad has published a well-illustrated and comprehensive work for the purpose of the Exposition, which will not fail to bring new visitors to this picturesque country.

If the progress of railroads consists in the luxury and comfort of the passengers, then the coaches of Pullman and Wagner, which are arranged with a luxuriousness heretofore unknown, are worthy of mention. An exhibit, remarkable for humanity and practical utility, are the cars of the Live Poultry Transportation Company in Chicago.

The result of the endeavors for the improvement of the railway system, especially for higher security, can best be seen in the new standards of permanent way, showing the abolishing of the joints and

the strengthening of the track. In the second I find much improvement in the construction of airbrakes.

Concerning the navigation companies, not much is to be said in this report. The most prominent exhibit is that of the North German Lloyd, which gives, besides the ordinary models and photographs, some very interesting statistics showing the importance of this well-known line.

In *group 897* (*methods and media of exchange*) I can only emphasize the complete United States Mint exhibit, and the artistically finished Russian, Danish, and German paper currency and bonds.

The *groups 898–901* (*warehouse systems, boards of trade, exchanges*) are rather poorly represented, the only things worthy to be mentioned are the freight and coal-handling machinery of the link belt companies Chicago, New York, and Philadelphia, the exhibit of pneumatic tubes as cash carriers (Borledo Package and Cash Carrier Company), and the instructive exhibit of the business colleges, giving their plan of work. Otherwise I have found only short pamphlets and photographs.

Class 902 (*insurance companies*).—Although it was expected that this class would bring rich material, yet it is very sparingly represented. It was fair to expect that the American companies, which hold a prominent and in some places a dominant position through all parts of the world, would show interest for the Exposition. The exhibits consist mainly of photographs; statistics are given only for the New York Life Insurance Company and the insurance department of the State of New York. The best exhibit in this class is given by the Nippon Life Insurance Company in Japan. This company, although established only in 1889, has 128 agencies in Japan. It is well conducted on practical business principles and effects ten different kinds of life insurance. The blanks of application are very carefully prepared. They contain 26 questions, some of which being especially adapted to the Japanese character and mode of life.

The *classes 903–906* are mainly represented by photographs, special exhibits of express companies were made in the California building (Wells, Fargo & Co.) and in Midway Plaisance (Adams).

GROUP 155.—INSTITUTIONS AND ORGANIZATIONS FOR THE INCREASE AND DIFFUSION OF KNOWLEDGE.

Classes 907–910.—Most academies of science and letters, and some of the most important publication societies, have considered it an honor to be worthily represented at this Exposition. Besides the magnificent display of the Smithsonian Institution and the National Museum of Washington the efforts of the foreign countries in this direction should be acknowledged with thanks. Here also New South Wales ranks first, as it has exhibited beautiful collections of minerals, wool, fruits, and seeds. Mexico, especially the governments of Puebla and Yuca-

tan, have also sent interesting collections. Many of the collections made expressly for the Exposition have a great value to museums, collected for commercial purposes, and were highly appreciated by experts.

Among the various and beautiful exhibits I have found the collections of minerals and horticultural and agricultural products especially interesting and instructive. They will undoubtedly find worthy treatment in the reports of the interested committees, just as the fine ethnological displays in the anthropological building.

Class 911 (libraries).—The only countries which have sent library exhibits are the United States and the German Empire. The American exhibit is arranged by the library school at Albany, N. Y., as the representative of the American Library Association; the German, which contains only the scientific libraries, by Dr. Graesel, of Berlin. Both show all branches of administration; they contain printed books concerning libraries, catalogues, pictures of library buildings—both external and internal—forms, reports, and statistics.

The American libraries are more of a public nature. They aim to distribute knowledge among all classes. For this reason we find here popular books, ready access, long hours of opening, support of the Government, and special legislation. The catalogues are written in a popular style.

In the German libraries sceintific interest prevails. They are for thorough research, and so books may be taken out for longer time than in America. The librarians are especially educated for this work and they themselves select the books for the libraries. The catalogues are scientific works and are only for the use of experts. Popular libraries are in Germany very rare, but are now coming into existence.

Group 156 (social, industrial, and cooperative associations) is not worthily represented in the Exposition. France alone, which did not enter in competition, has over two subjects, while the official catalogue shows for all other countries combined only eighteen subjects. Of these Germany has the best exhibit. The German Empire sent a number of books and statistics concerning the workman's insurance, established by laws during the past nine years, and the Imperial insurance department has expressly prepared an instructive pamphlet for the Exposition. The three branches of insurance—the sickness, accident, invalid and old age insurance, supplementing one another—mutually form a complete organization, which in its further development can not fail to exercise a great and salutary influence on the economical and social condition of the working people. In the few years since these measures became law nearly 1,000,000,000 marks, almost one-half contributed by the employers, have been expended in the interests of the workmen.

The trade unions in Germany are not so important as they are in England and America, nevertheless just those which have sent their litera-

ture to Chicago, the Verband deutscher Gewerkvereine, are highly esteemed for their efforts in avoiding riots, promoting good feeling between employers and employed, facilitating the obtaining of employment and for leading the working class to higher moral and intellectual fields.

Of Germany, we have yet to observe the charitable societies established and conducted by women, in connection with which a very interesting paper was published by Dr. Henrietta Tiburtins, for the especial purpose of the Exposition.

The Russian women's associations also have profited by the occasion to show that they are also entitled to a high rank for charitable works.

Concerning the question of dwellings for workmen, which for the past fifty years has taken an important position in consideration of social questions, we are sorry to observe that the Exposition has not served to greatly promote the same, a state of things which is still more to be deplored in view of the fact that also the French authorities generally complain of the too great uniformity in the plans of construction of such dwellings. The exhibit of plans of workmen's dwellings and institutions for recreation and education, for which Krupp offered prizes and which are displayed in albums in the pavilion, is very creditable. The pictures of those dwellings already built are also of great interest. Further, we must remark the dwellings of Philadelphia and New York as being the only specimens of complete houses, whereas at the Paris Exposition of 1889 this department was much fuller represented.

The Philadelphia workman's home is a handsome two-story brick house, which can be built for about $3,000, a sum that seems rather large, but as a matter of fact we must say that just in Philadelphia it is possible for the poorer classes to acquire in time the ownership of their dwellings through the easy conditions of payment. Of the 200,000 families in Philadelphia, four-fifths live in separate dwellings and two-thirds own them.

The New York house is frame, and can be built for $1,000. It contains two living rooms, three bedrooms, kitchen, bathroom, and three closets. The model house is built of good material and sanitary plumbing. The furnishing of the house costs about $300, perhaps a little too expensive for the ordinary workman. These dwellings can not fail to be of interest to both workmen and capitalists.

Of the highest importance is the report of the Massachusetts cooperative banks and building associations, prepared for the World's Columbian Exposition by D. Eldredge, of Boston. It gives an instructive history and valuable statistics. The report of 1892 shows in existence 115 banks with a membership of 54,484, holding 405,567 shares; assets, $14,620,275.73. In 1879, the second year after the foundation, there were but 10 associations, with 2,296 members, 10,861 shares, and assets of $205,235.43.

We must also mention the Workingmen's Loan Association, which has sent a clear report and good forms. The purpose is to rescue the poor from the professional money lenders, who, in Boston, where the association was founded, used to take 3 to 10 per cent per month of interest upon chattel mortgage of furniture and of other personal property. The work of this association is very creditable and worthy of imitation.

I can not fail to mention the valuable reports of the Charity Organization Society of London, England. Words of praise for this model society, which has found disciples in many, but I am sorry to say not in all countries, are superfluous. The introduction to the English exhibits published by the Charity Organization Society in London is very valuable, especially through the instructive and practical charts, giving a full account of the tasks, the work, the growth, and the necessity of this admirable society.

New South Wales has sent a list of her social, industrial, political, and cooperative associations. This list, prepared by E. W. O'Sullivan, M. P., for the Exposition, shows the interest and activity of the people of this country in social matters.

GROUP 157.—RELIGIOUS ORGANIZATIONS AND SYSTEMS.

This group is peculiarly American. A great many churches and sects have sent their publications, among which some are worthy of mention by reason of historical interest. The Universal Peace Union League, which also has found its place in this group, has exhibited a large number of publications and tracts, some of which are eloquent witnesses of the aims and endeavors of this society. Interesting and valuable is the book Scientific Temperance Instruction in Schools and Colleges, by Mary K. Hunt, superintendent. Further remarkable is the work done by the American Tract Society, which prints religious literature and schoolbooks in different languages.

The work done by the American Bible Society in New York, which has published the Bible in two hundred and forty-two different languages and dialects, is of high value for the history of civilization.

Interesting statistics have been given out by the Young Men's Christian Association. This society has 250,000 members in the United States, and does much work for the intellectual and social education and the moral development of its members.

HAIR.

BY

ELLEN D. BACON.

HAIR.

By Ellen D. Bacon.

Hair, since the beginning of the world, has ever been one of its chief beauties. Painters have immortalized it, poets sang its praises, and its possession is as much prized to-day as thousands of years ago.

A hair is not the smooth cylinder that it appears to the casual observer. It is composed of numbers of tiny, horny luminaii, somewhat as if quantities of thimbles were placed one within another, with an opening at the closed end of the thimble. The pigment cells have been analyzed by Liebig, who finds their constitution differing according to their color, in this manner:

	Fair hair.	Brown hair.	Black hair.
Carbon	40-345	49-622	50-935
Hydrogen	6-576	6-613	6-631
Nitrogen	17-936	17-936	17-936
Sulphur and oxygen	26-829	25-498	24-143

From this it seems that golden hair owes its brightness to an excess of sulphur and oxygen, with a deficiency of carbon, while black hair owes its jetty aspect to an excess of carbon and a deficiency of sulphur and oxygen. Vaquelin traces an oxide of iron in black hair, also in red hair. The coloring matter, however, forms but one portion of the difference existing between the soft luxuriant tangles of the Saxon and the coarse blue-black locks of the North American Indian. The size and quality of hair, and the manner in which it is planted, tells greatly in determining the race line.

An ancient German has undergone the immense labor of counting the number of hairs in heads of four different colors. In a blonde he found 140,400 hairs, in a brown 109,440, in a black 102,962, and in a red head 88,740. That the red and black lack in numbers was compensated in bulk, so that the scalps were probably about equal in weight. It is to the fineness and multiplicity of hairs that blonde tresses owe their rich silkness, which has made them such a delight to artists.

There is a beautiful kind of fair hair that has a peculiar shimmer like metal, to which is applied the word "golden." Some black hair has quite a blue steel-like luster where the lights are like flashes of blue steel. The mixture of white in black hair losing its color is also metallic in character, like gray steel or the fracture of iron, and is

called "iron gray." Another kind of gray hair is called "silver," resembling that metal. Still greater is the diversity in warm tints; pale gold runs into full gold, that into coppery color. Then there is red, auburn, and lastly dark, almost black hair, with shades of red in it, but this is very rare.

In this country red hair was formerly more derided than praised. Of late years we have begun to appreciate its beauty, immortalized by Titian, Georgina, and Paolo Veronese.

The hair of the albino is white, like floss silk or spun glass, and in itself is a thing of beauty. Among the Indians who dwell upon the banks of the Amazon white hair is solely an attribute of age, as they retain the blackness of their abundant long straight locks to the ages of 70 or 80.

As a rule, with all nations, gray hair is a sign of age at much earlier years than the above, yet sometimes it is hereditary with young people, and is now no longer concealed by dye or wigs, but proudly worn as most beautiful and becoming.

Sometimes illness, sudden terror, or great mental disturbance will blanch the hair, as in the case of Marie Antoinette, whose head turned gray during the night preceding her execution. In such cases it is presumable that the blood sends some fluid amongst the pigment of the hair, causing it to discharge its color.

The strangest hair is that of the Hottentots and Bushmen, which grows over their heads in little tight knots, like periwinkle shells, with interstices between on the scalp perfectly bare. This to us would be far from beautiful, but in their country is considered the perfection of hair dressing.

Some nations shave their heads to a single topknot, which, monopolizing all the nourishment, grows, as with the Chinese, to great length. These braided tails are often coiled about their heads, forming so substantial a covering as to resist a sword cut. But fashion leaves the sides of the head bare, unprotected, and blue, from continuous shaving.

The Japanese men and women wear their abundant black locks intact, taking much delight in combing and oiling them. The women whom we all saw in the Japanese village at the Chicago Columbian Exposition of 1893 had a fascinating way of twining the long shining black locks through their fingers and securely knotting it on the back of the head without aid of comb or hairpins, a marvel to all who saw it thus quickly and deftly arranged.

In the eleventh chapter of the First Epistle to the Corinthians, St. Paul announces that "long hair is a shame unto a man, but a glory unto a woman." This probably alluded to some special extravagance on the part of the Corinthians, and not to men's hair hanging only to their shoulders, as Milton describes that of Adam, whilst Eve's "hung down to her lovely waist."

The occupation of the sexes seems to account for men usually wearing their hair shorter than women so as not to interfere with their robuster exercises. There are occasional exceptions to this rule, as in some tribes of North American Indians, whose warriors encourage their hair to grow to inordinate length, for it is the women who do all the actual hard work, whilst the braves, in intervals of chase or war, lounge about their wigwams, giving undivided attention to their long hair. Also in Brittany, in former days, men wore their hair long, and the women cut and sold theirs, concealing what remained under large white caps or bonnets, vastly preferring these artificial creations of linen and starch to dame nature's handiwork. Indeed, until lately a woman was not considered in full dress while a single tress could be seen. But the world moves, even in Brittany, the main center of the present hair trade. Bonnets are not so universally worn, and the market may languish in future years for lack of material.

WIGS.

Who made the first wig? This question carries us far back into past ages, for have not wigs and artificial beards been unearthed from ancient Egyptian sarcophagi of Pharaoh's time? Who knows but that all those majestic Ninevites of sculpture, whom Mr. Layard discovered, with wonderfully twisted back hair covering their shoulders may not have borrowed much of their dignity from the hair and beards of their captives, manufactured for their use by the skillful hands of Assyrian barbers?

The Greeks wore their hair short and curled, confined by a fillet. It is only in the antique busts of the so-called "barbarians" that we find the locks flowing. The Greek women encouraged the growth of their hair, and bound it in various graceful ways at the back and top of the head. Among the antique busts we remark a great variety of hair dressing, even among the semblances of the gods. Jupiter and Hercules, Mercury and Apollo have each their particular characteristics. Homer, who sang of them all, has yet another style, as represented in a fine head in the British Museum, and another in the Naples Museum, which have long thin hair, smoothed carefully forward and confined with a fillet, so that the tresses curl gracefully on either side. The thatch, so to speak, of the brain has commonly been cared for and its absence regretted.

In the Greek divisions of the head into four parts of upright measurement one-quarter was allowed for forehead and one for hair, of which the line of growth was a regular arch from ear to ear over the forehead, making it thus small and low rather than expanded. The Romans carried this rule still further, and after going to the extreme in baldness with busts and statues brought the line of hair very low over the eyebrows, as in the beautiful and well-known bust of "Clytie"

in the British Museum. Occasionally the Roman women cut their hair quite short, dressing it so artificially and in so many short curls that a wig is strongly suggested, as in the otherwise charming sitting statue of "Agrippina" in Rome.

About the year 300 B. C., Ticinius Mænas brought barbers from Sicily to Rome, who first introduced the custom of shaving and perfuming the hair. Men did not shave until 21 years of age, when the beard was cut off in solemn assembly and consecrated to some favorite god, the crop of hair being cut at the same time and usually dedicated to Apollo. The Romans continued to shave up to the time of Hadrian, who, having an ugly, blotchy skin, hid it, so far as possible, by means of his beard. The Emperor's example naturally was followed, but on Hadrian's death (138 A. D.) shaving was resumed.

FALSE HAIR.

In the satires of Martial (43–104 A. D.) we first find mention of false hair. He speaks of it as "capillamentum," or "gericulum," in such manner that we presume the false hair was affixed to the skin. Its wearing was not likely to be discontinued, as it added much to personal comfort and vanity, and we may safely assume that at the disruption of the empire, when materials for progress were scattered far and wide among other nations, that the art of manufacturing false hair was one of the benefits thus widely disseminated.

PLATE No. 1.

HAIR IN FRANCE IN THE SEVENTEENTH CENTURY.

Louis XIII (1601–1643) had never cut his hair from childhood, and the peruke or wig was invented to enable those to be fashionable to whom nature had not been so lavish in flowing locks. Under Louis XIV (1638–1715) the size of perukes had so grown that the face appeared as a small hickory nut in the midst of a vast sea of hair (see plate No. 1) which for a long time retained its natural color.

HAIR IN ENGLAND IN THE SEVENTEENTH CENTURY.

In Milton's time (1608–1674), during the reign of Charles I, Charles II, and the Commonwealth, even the Puritans at first wore their hair in Adam's fashion, but afterwards cut it much shorter than did the Cavaliers, from whence came the name of "crop-eared knaves," and "Roundheads." Some portraits testify that Cromwell originally wore long hair, and his secretary, the author of Paradise Lost, wore his parted, and flowing in waves to his shoulders, like his own Adam. Soon after this it became the custom for men who had excellent hair

of their own to have it shorn and wear a wig, which indeed was an indication of gentility. In 1714 (the date of George I's ascension to the English throne) it was à la mode to have the wig bleached, which process resulted in such a dingy, ashen-gray hue that powder was applied—a wonderful device—which spread from Paris all over Europe. This fashion of wigs had its advantages, as a busy man might send his wig to be dressed without disturbance to himself, but on the whole the disadvantages predominated, and in 1752 the natural hair, powdered and tied into a queue, was universally worn, to rout which in France required a revolution, and it fell with the monarchy in 1793.

In England queues continued until 1808,

PLATE No. 2.—Hairdressing in New England in 1801.

PLATE No. 3.—Hairdressing in New England in 1801.

when they were abolished by an order from George III. In American portraits taken both before and shortly after that date we notice the queue without powder. (See plate No. 2.) The women of that time wore their hair negligently arranged, and bound by a fillet (as in plate No. 3.) During this time, in 1700, the fair sex were not behind their lords in hair ornamentation, as a stroll through portrait galleries of those days will testify. What horrible inflictions must they not have undergone, when they partially abandoned wigs and piled up their own hair to immense height on frameworks filled out with wool, tow, and hemp and covered with false curls, rolls of hair, pomade, feathers, flowers,

and jewelry. Those who still continued to wear wigs, arranged in the prevailing style, were more fortunate, as they could be dressed independently, for the labor of building up this strange structure on the head prevented its being done frequently, so that it was not renewed for several weeks, being retouched externally and covered with fresh odors to conceal any disagreeability which might issue from the interior. With this knowledge we can easily believe the accounts given by those who wrote and preached against these ridiculous enormities of fashion, and who assure us that the interior of these headdresses were commonly filled with vermin.

PLATE No. 4.—A London fashion in 1777.

In the London Magazine for August, 1768, a correspondent says: "I went to visit an elderly aunt, whom I found pulling off her cap and tendering her head to the ingenuous Mr. Gilchrist, who has lately obliged the public with a most excellent essay on hair. He asked how long since her head had been opened and repaired; she answered, 'Not above nine weeks.' To which he replied, 'That was as long as a head could well go in summer,' for he confessed that 'it began to be a little hasardé.'" The description which follows of the opening of the headgear is too disgusting to repeat. (See plate 4.) The men too piled up their wigs, as in plate 5.

PLATE No. 5.—An exquisite, or "maccaroni," in London, 1773.

Some of Gainsborough's (1727–1788) portraits, and many by French artists, of ladies of the French court, perpetuate this frightful fantasy, accredited to the unfortunate Marie Antoinette, and it is worth mention that while this English artist was slowly winning his fame at Bath, there dwelt in that same city a hairdresser of such transcendent talent that he was far more honored and better paid than the painter. So highly was he prized that ladies of fashion would submit to his operations, days before they were to exhibit at some brilliant fête, sleeping at night in an upright fashion lest his artistic work might be damaged. Truly, the advice given by St. Peter nearly nineteen hundred years ago, at a period when the cultivation of hair was of much interest to Roman ladies, was not heeded

by these votaries of fashion: "Whose adorning, let it not be that outward adorning of plaiting the hair, and of wearing of gold, or of putting on of apparel; but let it be * * * that which is not corruptible, even the ornament of a meek and quiet spirit, which is in the sight of God of great price."

WIGS OF THE PRESENT DAY,

As demonstrated in the exhibits at the Columbian Exposition, are more perfect as works of art and convenience than ever before, and are triumphs of manual skill and mental deliberation. The present ventilated hair-foundation wig is made upon a lace foundation composed of human hair itself, so that its weight is nothing, and into this are crotched the hairs one by one, and when placed upon the head the parting shows the veritable scalp from which each hair seems growing. So perfect a result that those who wear them now need be under no apprehension lest the world may penetrate their secrets. The artists in hair are mostly women, whose slender, deft fingers render them especially adapted for this work.

Messrs. J. F. Armand & Co., of Toronto, Canada, showed a man's gray wig, ventilated vegetable foundation, weighing three-fourths of an ounce, price $24. A most artistic and beautiful piece of work, as was also a woman's wig of white hair, 24 inches long, weight 1½ ounces, cost $42. E. Burnham, of Chicago, showed a beautiful wig of gray hair for a man, made on ventilated hair-foundation, weight 1 ounce. Ladies' fronts made in the same way. All the above exhibits were so perfect that it was impossible to tell where art ended and nature began.

EXHIBITS FROM DIFFERENT COUNTRIES.

Exhibitors in hair applied for awards from Great Britain, Argentine Republic, Mexico, and the United States. The following received awards for excellence of design and execution.

GREAT BRITAIN.

Represented by J. F. Armand & Co., Toronto, Canada, made an exhibit of everything pertaining to the artist in hair. Besides the two wigs spoken of above, showed a complete line of wigs, bangs, switches, fronts, curls, puffs, and hair jewelry, all of great beauty and excellence. Average cost of bands and curls, $2.75; switches, $7 to $12. Workmen's average wages, $12 per week. Average price for prepared hair, $20 per pound. They import from Paris, London, and Oppenheim, Germany.

MEXICO.

Mexico sent many articles of hair work. The most notable who received awards are: Elena Reyes, Guadalajara, exhibited a case of hair jewelry and flowers; a necklace rope, hollow, beautifully braided; exquisitely fine hair-lace work made into rosettes, serpent-twined bracelets, and pansy breastpin and earrings, and fine spray of flowers, all very original in design. Vicenta Loreto showed handsome hair jewelry, broad bracelet jetted with beads, two beautifully woven open-work flat necklaces, spray-of-flowers breastpin, earrings in shape of shells, and a hair ring. Margarita Perche, two hair chains mounted in gold. Josef Solas, cigar case of horse hair, very finely woven, close and durable.

ARGENTINE REPUBLIC.

The following deserve special mention: H. Thierry, Buenos Ayres, exhibited a truly wonderful life-sized portrait of Gambetta, worked entirely with human hair. Agel Scopati, Buenos Ayres, exhibited horsehair, very clean and long, to be used for upholstery and mattresses; also bags, made by hand, of tightly woven horsehair, to be used for straining grease in the manufacture of candles, and so prevent impurities from passing into the molds; also hair jewelry, bracelets, necklaces, earrings, pins, and brooches. Jesus Castaño, Buenos Ayres, exhibited beautifully wrought hair flowers.

UNITED STATES.

E. Burnham, of Chicago, made the largest and handsomest exhibit from the United States of everything pertaining to hair and its work, all on ventilated hair foundation—wigs, fronts, bangs, coiffures, curls, puffs, switches, coronets, rolls, plats, scalps, chignons, scratches, and hair jewelry; also a finely executed portrait of General Grant in hair. Mr. Burnham buys some of his goods directly from Europe, also through commission houses in New York.

HAIR TRADE.

Among the many curious trades is that of the traveling human-hair merchant, who obtains it from convents and from the rural districts and villages whose women grow their hair year after year for the market, and see nothing humiliating in turning an honest penny by its sale. Ordinarily a small portion of the front hair is reserved and cleverly arranged to conceal the ravages of the shears. The traveling hair merchant reaps what has been appropriately termed the "hair harvest." Each man has a specified district, throughout which he is well known, and starts on his journey early in the summer, when the natural covering of the head may be removed without serious damage to the owner. He starts with cash to pay for his goods, and also with

a fine assortment of cheap jewelry and trinkets of all kinds. Formerly hair was as willingly sold in exchange for such ornaments as for cash, but at the present day the peasant generally knows the value of filthy lucre, and prefers her payment through that medium. The arrival of the hair merchant at certain places, always occurring at the same time in the year, needs no advertising, as customers are awaiting him. Fortunately for the women there is a competition among buyers, and at country fairs girls may be seen wandering from one shearing booth to another, their long tresses streaming in the wind, in order to procure an additional cent or more upon their flowing crops. The business is managed rapidly, the severance being accomplished in two minutes. As soon as the hair is cut it is tied up, weighed, paid for (the price having previously been settled), and thrown into a basket, the weight varying from one-half pound to 1 pound. Formerly the poor girls were exposed to robbery. While traversing country roads they were often waylaid by ruffians, who, amidst brutal jokes, would shear them of their marketable commodity. This became so common in Brittany and Germany that it almost extinguished the trade, and was only subdued by severe punishment. The hair trade after this is carried on by wholesale merchants, who pay the collectors a fair percentage and, after preparing it for market, sell it to the hairdressers. Paris, being the center of fashion, is naturally the depot of such fashionable material, but it must not be supposed that the annual weight which passes through French hands is entirely the growth of French soil. France imports from Spain, Italy, China, Japan, Germany, Belgium, and other countries, as the following official returns for the year 1892 will show.

	Hair unmanufactured.	Hair manufactured.
	Kilograms.	*Kilograms.*
Spain	1,300	.....
Italy	33,839	111
China	26,294	.....
Japan	1,672	240
Germany	.....	247
Belgium	.....	350
Other countries	1,317	142
Total	64,422	1,090
Value in francs	347,810	20,425
Value per unit, francs	6	25

PRICES.

This may be taken as the actual general market value at wholesale rates. In Canada the average price of prepared hair is $20 per pound. In the United States the average price of ordinary prepared hair is $10 per pound. Blonde and golden hair are more expensive than other colors, costing 25 to 100 per cent more, according to texture and shade. Pure white hair, 24 inches long, is worth $40 per ounce, and less pro rata, according to the amount of colored hair mixed with it.

French exports in 1892.

	Hair unmanufactured.	Hair manufactured.
	Kilograms.	*Kilograms.*
Belgium	1,207	.....
England	744	1,542
Spain	1,929	.....
Italy	1,186	.....
United States	4,668	4,571
Germany	.....	909
Other countries	1,149	2,308
Total	10,883	9,330
Value in francs	121,884	195,930
Value per unit, francs	14	30

From this, incredible as it may seem, we find that the French imports of unmanufactured hair in 1892 were $63\frac{609}{2240}$ tons, or 141,729 pounds. Of manufactured hair, in that same year, France imported $1\frac{158}{2240}$ tons, or 2,398 pounds. She exported the largest amount of hair to the United States—of unmanufactured hair she sent us over $4\frac{1}{2}$ tons, or 10,269 pounds, and of manufactured hair $4\frac{496}{2240}$ tons, or 10,056 pounds.

HAIR IMPORTED INTO THE UNITED STATES.

I have been unable to find any other statistics with regard to the amount of hair imported into the United States of late, though the cost value of the imports are given by our Government for four years, and run thus:

Years.	Human hair raw, uncleaned, and not drawn.	Human hair clean and drawn, not manufactured.	Human hair, manufactured.
1890	.....	$25,260.00	$28,819.00
1891	$76,318.00	32,514.51	31,521.00
1892	97,118.00	33,596.40	25,028.00
1893	84,246.00	37,842.00	24,509.49

It will thus be seen that, as our dealers gain in dexterity, less manufactured hair is imported and more in the raw state. It is probable that 100,000 pounds of human hair was imported by the United States last year, chiefly from Paris and Germany. England has hair collectors who gather up, dress, and prepare for the market, not only the spolia of hair-dressers' shops, but that from private houses and institutions. In this country we have not yet become so provident.

BALDNESS.

It is impossible to state with accuracy how ancient is the prejudice against baldness. Julius Cæsar (who was killed 44 B. C.) petitioned the Senate for permission to wear a wreath of laurel in public to conceal, as he said, the loss of his hair, though, perchance, he aimed to

accustom the populace to his wearing the semblance of a crown! The Emperor Tiberius (42 B. C.–72 A. D.) wrote a treatise on the management and preservation of the hair.

We are now inclined to claim for the unclouded forehead a greater elevation than did either the Greeks or Romans, and it may be noticed in works of to-day, where beauty and dignity are sought, that considerable more than one-quarter of up-right measurement is allotted to the frank, uncovered forehead. This clear brow is the attribute of man, and there is peculiar intellectuality in a clear temple, as if, indeed, those parts were especially the thrones of thought—as if where the bone is thinnest, the brain is most recognized. Therefore the noblest and most intellectual character in male form is gained when the hair is somewhat sacrificed to the head, when the forward and nobler portions have apparently grown bare through exercise, the hair being confined to the back part of the head. Such is the case with many of our most intelligent men of the present day, and such was the appearance of Shakespeare when 35 years of age, who, in the "Comedy of Errors," indulges in this quaint raillery on the subject. Antipholus asks "'why is time such a niggard of hair, being as it is, so plentiful an excrement?" Dromio answers, "because it is a blessing that he bestows on beasts; and what he hath scanted men in hair, he hath given them in wit."

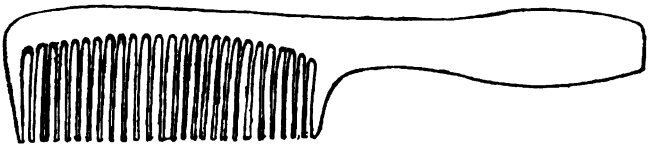
COMBS.

Combs seem to have been used by the ancients rather for adjusting than for fastening the hair, the pin or bodkin (acus) having been chiefly employed for the latter purpose. For hair combing both wooden and ivory combs were used in Egypt, with teeth on one side. Greek combs were made of boxwood, obtained from the shores of the Euxine. Later, they were made of gold, silver, bronze, and iron. The early Romans had some combs with teeth on both sides, like our fine-tooth combs. Ladies' high combs, as an article of dress and luxury, date back many centuries. The highest and rarest carvings of tortoise shell were worn in Spain and also in France, where combs of ivory, inlaid with gold and pearls, were still more fashionable among dames of rank. Spain still keeps up its reputation at the present day, as was demonstrated by an exhibit made by M. Martruda, Salvigdon, Provencals, which added to its many medals by one from our Columbian Exposition.

Combs are now mostly made of horn, bone, and india rubber. Horn is softened and split into thin scales and these are pressed into plates the size, shape, and thickness of the comb, which is then cut by machinery. Most admirable imitations of tortoise shell are made by dyeing the horn. Ox and cow horns come from South America and Australia, and buffalo horns from India, China, and Siam.

Messrs. S. R. Stewart & Co., of Aberdeen, Scotland, made a fine horn-comb exhibit, which received an award, making their thirteenth award from different countries. They employ about 1,000 hands in their works, and cut up 100,000 horns per week.

India-rubber combs are now most extensively used and are manufactured by pressing the caoutchouc to the required form in molds, after-



wards vulcanizing or combining it with sulphur. The most convenient style of these for use is made with a handle. (See plate No. 6.)

HAIR TOOLS.

Nichols & Co., of Chicago, Ill., exhibited fine curling irons, of new make, with wooden handles to prevent burning the hands, and received awards for these and some new patent fixtures to put over gas and kerosene lamps to heat the curling irons.

HORTICULTURE.

THE CANNAS.

By Fred Kanst.

In reference to this group, which is one of the most important of decorative plants, a review of its introduction, history, and development is here recorded. All the species are originally from tropical India or South America, except Flaccida, which is a native of our Southern

"Canna Indica."

Plant of Madam Crozy, well developed.

States. Indica was first introduced to gardens in 1570. As a plant of economic value the Canna is of great importance. Its leaves were used as envelopes, from which circumstance the French name of the plant, Balsier, is said to have arisen. The common name, "Indian shot," arose from the fact that the plants have black seeds, which were used as shot in the destruction of small animals. The original species, both in Europe and this country, were cultivated for foliage effects rather than for their flowers. The flowers of all, excepting Iridiflora, are inconspicuous when compared with the magnificent varieties of to-day. The variety known as "Ehemanni" is the Iridiflora introduced from Peru in 1816.

As before mentioned, the Canna up to within the past fifteen years was grown in gardens as an ornamental foliage plant only, and many

Florence Vaughan.—Individual flower. Color, yellow spotted red.

of the dark-leaved varieties are as brilliant and effective as the Dracænas. With the development of the size of the flower came a reduc-

Alphonse Bouvier.—Individual flower. Color, deep glowing crimson.

tion in the stature of the plant. It is to the French raisers we owe the first and most marked improvements in the size and brilliant col-

oring of the flowers, and cultivators of seedlings of this country are turning their attention to the raising and distribution of new varieties. The exhibit at the World's Columbian Exposition was a most complete and unique display, which proves that the Canna in its present form is the most desirable plant for general garden ornamentation. There were on exhibition in round numbers 10,000 plants in 200 varieties.

The best and most desirable varieties will be found in the following list, and are so well known as to need no further description:

Madam Crozy.	François Crozy.	Paul Marquant.
Florence Vaughan.	Germania.	Paul Bruant.
Alphonse Bouvier.	J. C. Vaughan.	Count Horace de Choiseul.
Capt. P. de Suzzoni.	J. D. Cabos.	Columbia.
Egandale.		

CIDER AND FRUIT JUICES.

By LUDWIG SCHILLER, *Judge.*

The World's Columbian Exposition has proved to us the fact of many things. It has given us the opportunity to compare the products of the different countries of the globe, and we are now pretty well enabled to see which country is the first, which is the leader.

In the following I give my experience in a certain line of horticulture, which has been gained by comparison and conversation of and about such cider, perry, vinegar, and expressed juices of berries as have been exhibited.

As different as the fruits are which are gathered in different locations of the globe, just as different we find the manufactured products gained therefrom.

The comparison of the different wines has given the certainty that no Rhine wine can be produced anywhere else but on the Rhine; that no Bordeaux will grow but around Bordeaux. It is just the same with all berries and fruits. When taking the fruits gathered in the United States in comparison, it shows that pretty nearly every State produces a different fruit. The apples of the South differ from those of the Northern States in size, and especially in taste. The South produces a fruit of wonderful perfection, but the delicate and pleasant taste, the bouquet, if I may use the word, can only be found in fruits of the Northern States. This is caused by the different climate as well as by the soil, and this explains that France and Germany, which are situated farther north than the greater part of the United States, which here comes especially into consideration, must produce a better-tasting fruit than the United States usually does, which will also be found true, of course, in the perries, vinegars, and juices. The class I am speaking of concerns the juices of berries only.

When taking the catalogue in hand, we find that America is the smallest exhibitor in class 143, which gives us the right to say that other countries, especially the European, are ahead in the manufacture of juices. America, of course, is too young to know or to have made the experience for herself in the said line of horticulture; but Germany, which had gone through many hundred years of experience before the discovery of America, has had plenty of time to make trials in all different ways, and at the present the pressing of fruit juices has grown

to a very important industry all over Germany. I beg to excuse that I can only speak more plainly about Germany, as I have no experience whatever how far other countries of Europe have succeeded herein.

America gave us nine exhibitors, whereas Germany had thirty-seven, Great Britain two, and there were a few from other European states, but as they are not mentioned in the official catalogue, I am unable to recollect the exact number. This figure proves that this industry is mostly accomplished in Germany. In fact, there is hardly one great city in Germany which has not fruit presses, and pretty nearly all great farmers of the more intelligent classes press or prepare their own fruit juices, and many well-off families in cities do the same.

The way to prepare the juice is too well known and I do not think it necessary to lose any words about it, but it is well to know that the Government in Germany encourages the public in the way of offering prizes at local exhibitions, and sends out tutors to lecture on the preparation of fruit juices in order to increase the cultivation of such plants as can be of value in this respect. All public roads throughout Germany are planted on both sides with fruit trees, and many a wall of the railroad (I mean the elevation on which lies the track) is adapted for the cultivation of gooseberry, currant, and other bushes. The law forbids the public, by penalty, to destroy places where the blueberries and elderberries grow in the woods, and thus enriches every spot in the country. A slight record says that more than 1,000,000 marks are gained every year by the poor working classes in gathering blueberries, elderberries, and strawberries. How many millions could be obtained in a country many times larger and richer than Germany. This is a question of the welfare of the common public, and it is the duty of the state and everyone who can afford it to teach the public how to enrich its own property. This little berry, growing wild in the woods, has become in this day such an important factor that I have no hesitation in saying some people would starve if they could not gather the berries and sell them.

The wild-growing kinds of berries are the blueberry, huckleberry, elderberry, cranberry, strawberry, raspberry, and blackberry. But it shall not be said that some of these are not cultivated. It is a fact that we never had any result in the cultivation of blueberries, huckleberries, elderberries, and cranberries, whereas blackberries, raspberries, gooseberries, and strawberries have been improved to a very great perfection by cultivation, the latter, of course, only in so far as size is concerned; but we will never be able to get that beautiful flavor, that bouquet, to the cultivated strawberries that we find in the wild-growing berries. Raspberries and gooseberries are grown in large quantities all over Germany, and there is hardly one man who calls a property his own who does not grow them. There is, in fact, no child that does not know these berries and appreciate them.

The German Government erected schools, combined with trial fields, on which new kinds are to be proved, and the result, after examination by the chemist, is published in every newspaper. In this way a valuable plant is quickly known to everyone, and in a few years it may be found all over Germany.

Germany had on exhibition the juices of different berries, and no one took back his exhibit without getting a medal, which shows again that the products have been appreciated by the jurors. From a sanitary standpoint the juices of berries are very valuable, and a high place may be given especially to the elderberry and currant juices.

The sparkling cider of currants, as exhibited by A. H. Detert, Berlin, caused a great sensation among the jurors. It is so refreshing and of such a pleasant taste that even strict temperance people have been delighted with it, and I received many a flattering compliment for the perfection of the currant champagne. The currant wine exhibited by C. Wesche, Quedlinburg, received highest awards at exhibitions in France, England, and Germany, and is known as one of the best drinks for convalescents.

If judgment of these juices could have been rendered during the early part of the Fair the result would have been far greater, as most of the products suffered much from heat during the Fair, and in consequence of which the jurors could not get a full idea of the quality.

In comparison to the juices of the United States, I dare say that some ciders and vinegars have been of splendid quality, but in general the taste of the perry is too strong and the aftertaste not very pleasant, whereas only our gooseberry wine leaves an aftertaste.

It requires too great a study to be competent, and as I was engaged too much in the welfare of the exhibitors I represented, I do not like to say anything I could not take the responsibility for.

But if the study of this industry keeps on in America as it has been in the past, I do not doubt at all but that the spirit of the American people will get results which fully guarantee a well-paying line of industry.

GRAPES.

By SYLVESTER JOHNSON.

I was asked to act as juror in this group and began the work on August 5, 1892. Some of the early ripening grapes from the Southern States had been exhibited and passed upon by a juror prior to this date. Toward the latter part of August exhibition grapes began to arrive in great quantities and in a great number of varieties, as the following condensed exhibit shows:

	Plates.	Varieties.
Colorado	64	30
California	139	100
Idaho	16	9
Iowa	58	35
Illinois	169	109
Kansas	65	65
Minnesota	60	49
Michigan	63	44
Missouri	30	22
New York	1,324	225
New Jersey	220	85
Nebraska	10	10
Oregon	20	5
Ontario	464	65
Quebec	185	116
Wisconsin	263	93
Total	3,150	1,062

Numbers each of the ten leading varieties exhibited by each State and province.

States and provinces.	Varieties.									
	Agawam.	Brighton.	Concord.	Catawba.	Delaware.	Lindley.	Moore's Early.	Niagara.	Salem.	Worden.
Colorado	1	1	8	1	1	2	1	4	5	3
Iowa	1	1	2	1	1	2	1	3	1	1
Illinois	4	3	2	3	3	3	1	4	3	2
Kansas	1	1	1	1	1	1	1	1	1	1
Minnesota	1	2	3	1	2	2	1	1	1	1
Michigan	2	2	2	2	2	1	1	2	2	2
Missouri	1	1	2	1	4	1	1	1	1	1
New York	32	41	105	24	60	14	9	125	14	34
New Jersey	2	6	8	2	5	5	2	12	4	8
Nebraska	1	1	1	1	1	1	1	1	1	1
Ontario	11	51	19	2	54	32	5	122	6	14
Quebec	1	1	4	1	2	1	2	4	4	2
Wisconsin	4	12	8	3	13	8	4	10	4	8
Total	62	123	167	45	151	75	32	292	49	80

In addition to the native grapes above named, California, Colorado, Idaho, Oregon, and Washington exhibited very creditable collections indigenous to their respective localities. In comparing the grapes here named as with others, we are not to understand that their value as a table or market grape is to be gauged with the number of any given variety exhibited. Take, for example, the Niagara, of which there were nearly double the number of plates exhibited of any other variety, yet it falls far short, as a table grape, of the Delaware, Brighton, Wilder, Moore's Diamond, Salem, and some other varieties. But on account of the size of its fruit and cluster, as well as its productiveness, it is exceedingly attractive. In my opinion, no white grape at the Columbian Exposition attracted so much attention or caused so much favorable comment as the Niagara. Of the red grapes, the Brighton and Delaware stood at the head of the list for table use. The former, on account of its very fine flavor, its large cluster, and its rapid growth, is rapidly gaining favor in public esteem. The latter is nearly as good for the table, but on account of its size and the slow growth of the vine must take second place on the list of reds. Of the newer grapes demanding and worthy of more general cultivation are the Brilliant and Moore's Diamond, of which there were but few shown. The Worden as a black is, as it deserves, rapidly coming to the front, as 80 plates were exhibited. This is, in my opinion, superior in every respect to the Concord, yet not greatly so. There were a vast multitude of new hybridized and other seedlings exhibited, which, as a rule, hardly ever received markings over 5 in the scale of 1 to 10. I believe in the effort to produce a better grape the word acme will soon supplant that of excelsior.

EDUCATIONAL.

So far as your juror had time, which was not abundant, he applied himself to efforts to secure information in regard to the best methods of cultivating and training grapevines, and of preventing the destruction of the fruit by the depredation of birds, insects, and fungi. I found those that had the best, largest, and nearest perfect specimens were of that class who cultivate most frequently and thoroughly and fertilize the best. It was found that pruning must be closely and intelligently done, and that some of the more tender varieties must be taken from the trellis, laid on the ground, and partially, if not wholly, covered in winter. To prevent the attack of fungi, spraying, while not a perfect success, has been found highly beneficial, while sacking has been a perfect success in warding off fungi, insects, and birds. While the latter method is the more successful, it is also the more expensive, hence can not be recommended for large vineyards. The sacking, to be a perfect success, must be done just as the bloom drops. It was also found that location and surroundings have much to do in

making a success in grape growing. Those sections bordering on large bodies of water produced grapes in much greater abundance than those not so highly favored. A confirmation of this fact may be found by reference to Table B in this report. Look at New York, for instance, with her two large lakes on the north and northwest, together with her smaller lakes and rivers, and it will be readily seen why she produced nearly one-half of the grapes exhibited. Then, again, notice Ontario on the other side of the lakes, but similarly favored with plenty of water.

Having been connected with the fruit department at the Centennial Exposition eighteen years ago, I have been much interested in noting the vast improvement in the quality and increase of varieties since that time. New York alone exhibited more grapes and far better ones at the late Columbian Exposition than were exhibited by all the world at the Centennial Exposition.

HARDY PLANTS AND GARDEN DESIGNS.

By WARREN H. MANNING.

A report on the displays made under the classes 156, 157, and 192, in groups 22, 25, and 26, is requested, and will be made under the above title.

There were 74 exhibits of hardy plants out of doors; 10 from Germany, 9 from France, 5 from Holland, 4 from England, 2 from Belgium, 1 from Mexico, 1 from Japan, 1 from Canada, 1 from Austria, and 40 from the United States. These displays included woody and hardy herbaceous plants. Of woody plants there were about 1,600 species and varieties (exclusive of roses), representing about one-third of all in cultivation that are grown out of doors in temperate regions for garden decoration. Of hardy herbaceous perennials there were about 600 species and varieties, including nearly all of the kinds that are obtainable in American nurseries. This display was greatly superior in point of numbers to that at Philadelphia in 1876, where there were only 15 exhibitors of hardy plants out of doors. The average excellence of the plants was about the same as at that exposition.

I am not prepared to compare the arrangement of the plants at the two expositions, but as an aid to those having to do with an exposition of a similar character in the future I make the following notes and suggestions.

The exhibits at Chicago could properly be divided into two classes, one including exhibits, or those parts of exhibits that were made up of a few plants, of a large number of species and varieties, made chiefly for the purpose of displaying the exhibitor's resources, the other including a large number of plants of a limited number of kinds having a special value for decorative purposes, either on account of their showy flowers, abnormal foliage, or peculiar habits. The ground immediately about the woman's building was given up exclusively to the French exhibit. A few exhibits were in the nursery at the east end of the Midway Plaisance, but the larger number were on the Wooded Island. In the nursery on the Midway and about the woman's building a portion of the exhibits were in rows, a part in crowded beds, and a part standing as individuals. On the island and about the woman's building, and in a few cases in the nursery, it was evident that in general the primary motive in the mind of those who arranged

the displays was to secure a decorative effect. The use of such part of a display as was intended for this purpose was, of course, justifiable, but it almost wholly destroyed the value of the display of varieties, for they were so closely planted and so far from the walks, to which the public was closely confined, that even if they had been distinctly labeled the name could not have been distinguished, and the close examination of growth, bark, buds, foliage, flowers, and fruit, which one who is interested in such matters would like to make, was not possible. For an exhibit made up partly of plants of inferior merit, such an arrangement is an advantageous one, for the defects can be easily concealed; but an exhibit made up wholly of good specimens appears at a great disadvantage. If that part of an exhibit which was intended chiefly for decorative purposes had been separated from the display of varieties, and these last had been placed in nursery rows (or the herbaceous perennials in narrow beds), each standing as an individual and having an equal chance for growth and development, and these rows near enough to paths to enable an observer to read labels and make a close examination, the collections would have been of much greater educational value, more likely to show their true worth, and to have brought to the exhibitor an adequate return for the expense of making the display. In these respects, a few exhibits of fruit trees in the nursery, from France, were the best arranged.

As to points of advancement shown in this exhibition, over others of a similar character, some reference has already been made. There was little evidence of advancement in methods of propagation or growing, unless it be true that it is a more frequent practice to place young plants in beds, closely, for one or two years instead of planting at once in nursery rows. Methods of digging and transplanting are much the same as they have been, excepting that there has been an improvement in tools so that it can be done more expeditiously. In many nurseries "tree diggers" are used where spades were used exclusively a few years ago.

Within a few years many new and desirable species and garden varieties have been introduced into our nurseries, both among woody and herbaceous plants. The Retinosporas are nearly all of recent introduction; so also are the Japanese maples. The varieties of pyrethrums and gaillardias have nearly all been originated since 1876, and the varieties of hardy phlox are greatly increased and improved. *Iris Kæmpherii* is an introduction of recent years.

In the planting of public and private grounds more of the fine native American shrubs and trees are being used, hardy herbaceous perennials are much more common, tender bedding plants in formal patterns are going out of fashion. This change of fashion was indicated in the character of the exhibits at Chicago.

Different methods of propagation were to be seen in the displays at

Chicago. The roses were nearly all budded; species of deciduous trees and shrubs were mostly grown from cuttings or seeds. Some horticultural varieties were grown from cuttings, but most of such were budded or grafted near the ground on suitable sticks. This was true in nearly all displays excepting those from Holland, in which a large portion of the deciduous woody plants were grafted high or trained to stalks.

Believing that a better idea of the character of the exhibit as a whole could be gained from a somewhat detailed description of each exhibit, I have prepared such descriptions.

I have also added a list of the plants coming under the above heading that were in the various exhibits. This list is very nearly complete, and the names given in it correspond to those given on the labels. In many cases plants were named in the entries that were not on the grounds, and all such were omitted.

The E. H. Ricker Company, Elgin, Ill., exhibited 19 kinds of woody plants, nearly all in a variety of sizes. It was distinctly a wholesale nursery exhibit, in which were shown methods of growing, caring for, and handling trees, from the seedling bed to large transplanted specimens, with a view to instructing purchasers in the proper methods of handling stock, small stock especially, on its receipt. A specimen of planting for a wind-break was also shown, made up of Norway spruce and dwarf pine. The exhibit was a very meritorious one.

HORTICULTURAL DEPARTMENT.

A large number of hardy herbaceous plants were propagated and used on the wooded island by the department. A collection of hardy carnations, grown by Mr. Thorp, was particularly fine in the range of color and beauty of markings of the flowers. The plants thus grown were vigorous, and they all flowered freely.

The Bloomington Phœnix Nursery, Bloomington, Ill., exhibited about 14 species and varieties of woody plants.

D. Hill, Dundee, Ill., displayed 30 species and varieties of plants, mostly conifers. A part of these were well-established specimens of horticultural varieties about 30 inches high, but the greater number were transplanted seedlings and young plants, which were evidently carefully cared for and were in excellent condition. The collection was plainly labeled.

A. H. Gaston, North Harvey, Ill., exhibited, with a small collection of fruits, a variegated form of Catalpa.

Orange Judd, farmer, Chicago, Ill., exhibited a Virginia rail fence, with all the angles filled with a vigorous growth of wild plants—a picturesque object, but a prolific source of weed seed and vermin. By way of contrast, and as an example of what should be, there were displayed sections of woven-wire and of board fences, with clean-cut sod

under them. Inclosed by these fences was a weed garden, with 125 species of growing weeds, all designated by their common and botanical names. This I considered one of the most original, best arranged for its purpose, and most instructive exhibits of hardy plants on the grounds.

P. S. Petersen & Son, Chicago, Ill., exhibited 8 large transplanted trees, from 2 feet 5 inches to 4 feet 6 inches in circumference at 4 feet from the ground, which were healthy and well established—a very successful example of large tree moving, which is to be especially commended on account of the method of trimming, which does not injure the natural outline and character of the tree.

R. Douglas & Sons, Waukegan, Ill., exhibited 3 varieties of conifers. The trees were symmetrical, well furnished, and 3 to 5 feet high.

J. C. Vaughan, Chicago, Ill., exhibited 1 variety of rose and 8 varieties of azaleas.

E. A. Bechtel's Sons, Staunton, Ill., exhibited well-established trees of a double-flowered, fragrant form of *Pyrus angustifolia*, which promises to be of much ornamental value.

The B. A. Elliott Company, Pittsburg, Pa., exhibited 68 kinds of hardy herbaceous plants. Of many of the varieties a considerable number of each were arranged in formal patterns, in beds. Undoubtedly certain kinds of this class of plants can be used advantageously for ornamental planting of this character, but in this case the uneven size of the kinds of plants selected and frequent patches of bare ground marred the effect. It was evidently the purpose of this company to select varieties which were, on account of their flowers or foliage, of especial value for decorative purposes rather than to show an extensive collection, and it is to be commended for its success in carrying out this purpose.

George Achilles, Westchester, Pa., exhibited 11 kinds of conifers and 19 of deciduous shrubs. With few exceptions, the conifers were well furnished, symmetrical, and vigorous. The shrubs were above the average nursery plants in size.

George Craig, Philadelphia, Pa., exhibited 2 varieties of roses.

The Dingee-Conard Company, Westgrove, Pa., exhibited 15 varieties of hardy shrubs, which were stocky, vigorous, and well graded; of several kinds large numbers were shown. They also displayed 193 varieties of roses (the third largest display on the grounds) and 3 varieties of hardy herbaceous plants.

Pitcher & Manda, Shorthills, N. J., exhibited about 374 species and varieties of hardy herbaceous perennials. Of this number 18 were lilies, 82 named pyrethrums, and 63 named or numbered varieties of Japanese iris. The collection was the largest of its kind on the grounds. The miscellaneous plants were made up of reliable varieties that can be readily grown in almost every garden. The collection of

pyrethrums was a very choice one, and included both single and double forms in a full range of colors. The plants were strong and well established. The Japanese iris (*I. lævigata*) were in two sets, one with Japanese characters and the other numbered; nearly all the plants flowered; there were few duplicates, and the varieties were all good and some were new. This firm also exhibited a few woody plants and roses, including 12 varieties of rhododendrons.

E. D. Sturtevant, Bordentown, N. J., exhibited 29 aquatics, about 20 of which were hardy. The plants made a very fine display in the tanks of the interior court of the horticultural building.

Wm. F. Bassett & Son., Hammonton, N. J., made a small exhibit of hardy native herbaceous plants, and were the only exhibitors making such plants a specialty.

John W. May, Summit, N. J., exhibited 16 varieties of roses.

Earnest Asmus, West Hoboken, N. J., exhibited 2 varieties of roses.

F. W. Kelsey, 145 Broadway, New York, N. Y., exhibited 29 species and varieties of woody plants. Of these one-half were conifers, most of which had been trimmed so as to give them a formal outline. The other varieties were chiefly Japanese maples. The plants were generally well established and in good health. Associated with Mr. Kelsey's display was a fine lot of rhododendrons from Mr. John Waterer, under whose name they will be referred to.

Ellwanger & Barry, Rochester, N. Y., exhibited 90 species and varieties of woody plants, and a small collection of hardy herbaceous plants having superior flowers or attractive foliage. Of herbaceous plants a considerable number of each kind was displayed and they were so selected and arranged that a nearly continuous succession of masses of flowers were produced during the period of the fair. The woody plants were mostly first-class nursery specimens, but they were so crowded that it was difficult to determine their characters, and the labels were in many cases illegible. In very few collections were the plants so uniformly well grown and well established. This firm also exhibited a collection of roses and 4 varieties of azaleas.

New York State made an exhibit, the most notable feature of which were displays of double hollyhocks and Japanese iris. The iris plants were the finest, and their flowers were the best of any of their kind on the grounds. There was also in the State display a collection of 40 varieties of roses contributed by James Dean, Bay Ridge, N. Y.

Parsons & Sons Co., Flushing, N. Y., exhibited 162 species and varieties of woody plants, 24 of which were varieties of rhododendrons, and 15 of azaleas, 45 of conifers, 19 of Japanese maples, and the others miscellaneous woody plants. The plants were carefully selected specimens, above the ordinary nursery size, and were given plenty of room, so that they could be seen on all sides. Each plant was provided with a strong stake label, with the name legibly written. There were few exhibits more satisfactory in these respects than this.

G. Marc & Co., Woodside, N. Y., exhibited 16 varieties of roses.

California State exhibit included a few hardy plants, but it was made up chiefly of citrus fruits, olives, and palms. The display from this State was a notable one on account of its extent, for the size of the specimens that were transported, and for the successful results that were secured in their growth. Altogether there were about 107 species and varieties represented in the collection, including 7 varieties of roses.

California Nursery Company, Niles, Cal., exhibited 35 varieties of roses.

Mendenhall, Minneapolis, Minn., exhibited 4 varieties of roses.

Dayton Star Nursery Company, Dayton, Ohio, exhibited 11 varieties of roses.

Oregon State exhibited 8 species of the native conifers and 2 ferns that had been collected from the woods and fields. They were interesting as native plants and had stood the removal fairly well.

W. M. Samuels & Co., Clinton, Ky., exhibited plants of *Arundo donax variegata.*

Nanz & Neuner, Louisville, Ky., exhibited 36 varieties of roses.

E. G. Hill, Richmond, Ind., exhibited 16 varieties of roses.

Martin Klein, Detroit, Mich., exhibited several forms of *Prunus pumilla,* which were recommended for their fruits and for hedges.

Albert M. Todd, Kalamazoo, Mich., exhibited several varieties of hardy perennials from which essential oils are extracted.

W. C. Strong & Co., Waban, Mass., exhibited 2 roses of which growing plants had not before been exhibited at an international exposition.

Jacob W. Manning, Reading, Mass., exhibited 48 species and varieties of hardy herbaceous plants, among which were a few not in other exhibits. The most important display from this firm was in the grounds about the Massachusetts building, the decoration of which was designed and supplied by them. As this collection was more complete than any other used in this way and as it was made up chiefly of the class of plants referred to in this publication I have included it. There were represented about 150 species and varieties, of which about 100 were herbaceous perennials and 50 woody plants. It was designed that the planting about this building should be in keeping with the "old-fashioned" character of the house, and in this respect it was eminently successful. There was an abundance of flowers and a luxuriance of foliage throughout the term of the fair which testified to the good condition of the plants and to the attention that they received.

Rea Bros., Norwood, Mass., exhibited 95 kinds of hardy herbaceous plants, among which there were several that were not in other collections. Their collection was evidently selected with a view to a succession of flowers through the season, and of the best varieties

a number of plants were displayed. The collection was a good one, but the labels were very small, and in many cases missing or illegible.

D. Zierngieble, Needham, Mass., exhibited a new strain of Dianthus having the dwarf sturdy habit of *D. plumarius*, the color and markings of *D. chinensis*, *D. hedewegii*, *D. querterii*. The flowers had a good range of color, were produced for a long season, and were both single and double, with some tendency to burst the calyx in the double form.

Wisconsin State Horticultural Society, Evansville, Wis., exhibited a mixed collection of common varieties of fruit and ornamental trees (from J. C. Plumb & Son, Milton, Wis.); also a miniature cranberry bog, in which was illustrated the proper methods of construction, controlling and using water, planting and caring for plants. The last exhibit was well designed and maintained.

Geo. Pinney, Evergreen, Wis., exhibited 192 species and varieties of conifers. The collection was larger than that of any other exhibitor, but many of the plants were represented by very unsatisfactory specimens, which detracted from the merit of the collection as a whole. Notwithstanding this, the exhibitor is worthy of commendation for bringing together a collection of this extent.

Chas. E. Pennock, Bellevue, Colo., exhibits edible fruit-bearing plants native to Colorado; also fruits adapted to the climate of the State, about 15 varieties in all. The plants were well established in tubs. The purpose of the exhibit, and the exhibit as well, were creditable.

Central experimental station, Ottawa, Canada, exhibited 35 species and varieties of coniferous plants, among which forms of *Thuya occidentalis*, the Arbor vitæa, predominated. The plants averaged about 18 inches in height. They were displayed in pots and used chiefly as a decoration for the fruit display tables of Canada.

Anthony Waterer, Surrey, England, exhibited 108 varieties of woody plants, of which 89 were rhododendrons and 19 conifers; also a collection of new "Knap Hill azaleas." The collection of conifers was a notable one on account of the excellence of the specimens. They had been trained sufficiently to give them a symmetrical outline, but not to destroy their natural character. The rhododendrons were well-grown plants and full of flowers which were notable for their brilliant colors and good substance. Among the azaleas new types in color and flower were shown, which were an advance over most of the varieties of hardy azaleas now in cultivation.

John Waterer & Son, Bagshot, Surrey, England, exhibited, through Mr. Fred. W. Kelsey, of New York, a collection of 40 named rhododendrons that were not surpassed by any on the ground in the brilliancy and good substance of the flowers, and in the health and vigor of the plants.

Cannell & Son, Swanley, England, exhibited collections of 97 varieties of peonies and 51 of phlox. The plants were well established and vigorous. The selection of varieties was such that the display was one of the finest on the grounds.

Alex. Dickson & Sons, Newtonards, Ireland, exhibited 79 varieties of roses.

E. Sydenham, Budapest, Austria, exhibited 516 varieties of roses—the largest collection upon the grounds.

Boskoop-Holland Nursery Association, Boskoop, Holland (C. H. Joosten, agent, New York), made an exhibit of 116 varieties of azaleas 100 varieties of rhododendrons, 100 of clematis, 68 of trees and shrubs, and 50 of phlox. The azaleas and rhododendrons were healthy plants, and they made a fine display of flowers. The phlox included a large number of the well known older varieties and a number of interesting new forms. The clematis plants were better established and flowered more freely than any others on the grounds. The collection of trees and shrubs were mostly grafted on or trained to stems, a class of stock that is but little used and of little value in our gardens. Among the trees were a number of very fine magnolias in variety that had been trained to a cone. They were generally very successfully transplanted for plants of such size. This firm also exhibited 148 varieties of roses.

Jack Jurisson & Son, Narden, Holland, exhibited about 150 kinds of trees and shrubs. It was the largest collection of its class, and in it were a number of varieties very rare in or new to cultivation. It was noticed that there were several wrongly named plants. The plants were generally vigorous and well established, and altogether it was a very instructive and satisfactory exhibit. This firm also exhibited 150 varieties of roses, a large part of which were unnamed.

W. Van Kleef & Sons, Boskoop, Holland, exhibited 10 varieties of roses, 40 named varieties of rhododendrons, and a few miscellaneous woody and herbaceous plants.

Polman Mooy, Haarlem, Holland, exhibited about 5 varieties of hardy herbaceous plants.

J. B. Blaauw & Co., Boskoop, Holland, exhibited, through R. F. Dunning & Co., of Chicago, 50 named varieties of rhododendrons.

Unfortunately the Japanese Government exhibit did not become far enough advanced during the time of the Fair to give an indication of its true value. It was made up chiefly of plants displayed by the Tsuda Agricultural and Horticultural Association, of Tokyo, Japan, together with a number of large plants of the Japanese maples, on which were a great number of varieties grafted from Teshima-gore. In a list of exhibits of the above association 590 species and varieties were represented. Of this number 20 were fruits, chiefly citrus, persimmon, and chestnut, which were 4 to 6 feet high, and were well-established plants. Of *Iris laevigata* (Japan iris), 210 varieties were said to be

represented, but so few of the plants flowered that no idea of their merit was to be had. The same was true of lilies, of which 96 specimens were said to be represented. Of 71 varieties of Pteris that were said to be included, few were to be found. Of 100 varieties of Japanese maples, many were represented by potted plants, but the growth was so poor, owing to unfavorable conditions, that but little variation was evident, and it would appear from what variation there was that very slight distinctions must have been depended upon to make the number of varieties indicated. The miscellaneous ornamental plants were generally in good condition. It is to be regretted that the whole collection was not in the best condition, for undoubtedly there were rare plants in it.

Vilmorin, Andrieux & Co., Paris, France, exhibited 5 named varieties of Montbretia crocosmiæflora.

Pinguet-Guindon, Tours, France, exhibited a large collection of fruit trees and vines, and among them were 10 species of plants used for stocks.

Pepinieres de Lieusaint, Lieusaint, Seine et Marne, France, exhibited fruit trees.

Levavaseur & Son, Ussy, Calvados, France, exhibited a rose and a new variety of clematis, which was of considerable merit.

L. Paillet, Valle de Chatenay (Seine), France, exhibited 29 varieties of ornamental trees, and in the collection were a number of new varieties not before exhibited in America. This firm also made an exhibit of fruit trees.

Croux & Sons, Val d'Aulnay, at Sceaux, France, exhibited 52 kinds of woody plants, chiefly conifers. Nearly all of the plants were very fine specimens, the conifers especially so. There was no finer collection on the grounds with the same number of species and varieties represented, when the choice of varieties, the excellence of the specimens, and the success with which they had been transplanted, was considered. This firm also exhibited 50 varies of rhododendrons.

M. Moser & Son, Versailles, France, exhibited 111 species and varieties of woody plants. Of this number, 83 were varieties of rhododendrons and azaleas. In this collection were the largest and finest specimens of rhododendrons on the grounds. There were also a number of carefully trained pyramids and standards of conifers and broad-leaved evergreens, and in this respect this collection excelled others. Of the new plants exhibited, the two varieties of Dimorpanthus in this collection were notable additions to the list of hardy, ornamental foliage plants.

Honore Defresne & Fils, Vitry (Seine), Paris, France, exhibited 129 varieties of woody plants, the greater part of which were evergreens and more than one-half conifers. The collection of coniferous plants was made up of small specimens, but they were symmetrical and well

grown. The broad-leaved evergreens were partly low plants and partly trained to stems, and they were all well established and in fair growth. The nomenclature of the coniferæ was a good many years behind the times, but a redeeming feature was in the legibility of the labels.

G. Boucher, Paris, France, exhibited 64 named varieties of clematis, the largest collection on the grounds. The plants were plainly labeled and neatly trained to trellises, and a large part of them showed flowers.

Dresden florists and nurserymen, Dresden, Germany (R. Beyer, B. Hahnel, B. Haubold, C. W. Mietzsch, O. Olberg, H. Raue, A. Richter, L. R. Richter, P. Ruschpler, R. Weissbach), exhibited 57 varieties of roses.

Joseph Mock, Treves, Germany, exhibited 175 varieties of roses.

Carl Goerms, Potsdam, Germany, exhibited 305 varieties of roses, the largest collection, with one exception, on the grounds.

Lambert & Reiter, Treves, Germany, exhibited 1 variety of rose.

Kock & Rohlfs, Berlin, Germany, exhibited 57 varieties of clematis, which were, unfortunately, so injured in transit that their character could not be determined.

H. Wrede, Lüneburg, Germany, exhibited 38 varieties of phlox in which there were evidently some very fine varieties, but owing to lack of water they did not show their worth.

T. J. Seidel, Dresden, Germany, exhibited 5 varieties of rhododendrons.

Royal botanic gardens, Berlin, Germany, exhibited a collection of alpine plants in which there were probably more species not before exhibited in America than in any other collection, but before the season was past nearly all had died. The plants were placed in an artificial rockwork raised above the ground. In such a position they very likely would have succeeded in Germany, but not in this country with its blazing summer sun. There were originally about 103 species and varieties represented.

Oskar Tiefenthal, Wandsbeck, Germany, exhibited 11 varieties of roses, 2 of hardy herbaceous plants, and a bed of *Hydrangea paniculata grandiflora;* which was in full flower several weeks before others, in similar situations, on the grounds.

S. C. Vollert, Luebeck, Germany, exhibited 21 varieties of roses.

Ch. Vuylsteke, Ghent, Belgium, exhibited 15 named varieties of azaleas.

Belgian exhibitors of Ghent and vicinity (horticultural school, A. Dalliere, Desmet Bros.) exhibited 50 varieties of azaleas.

Mexican exhibit contained about 190 species and varieties, about a dozen of which were hardy.

Garden designs were made by sixteen exhibitors, representing Germany, France, England, Russia, and the United States. There was

less than half of this number of exhibitors at the Centennial Exposition, and the general excellence of the plans displayed was not as good as at Chicago. In the sixteen exhibits there was not enough material, excepting that of Germany, to form a fair comparison of the work of the designers of one country with that of another. Among all the designs of special merit, the natural treatment with its curved walks and irregular plantations predominated where the conditions would admit of such treatment. Without the topography indicated and with nothing to indicate the original character of the surface no judgment could be passed upon the skill of the designer in utilizing natural features or overcoming obstacles successfully. It was possible to make a fair comparison between various plans on the arrangement of buildings, yards and approaches, and on the general subdivision of the land and on the knowledge of special conditions presented by different problems and skill in providing for these conditions.

The finest display of plans was made by the city of Berlin, Germany. In this exhibit were 20 plans, executed in ink and water colors with great skill. A very wide range of conditions and requirements were presented in these plans and it was evident that they had been met with great skill and success.

W. Wendt, of Berlin, made a display of 26 plans of small places, in nearly all of which there was a similar arrangement of paths encircling the lawn and formal flower beds on the edge of the lawn next to the house.

Hector G. Eck, of Dresden, exhibited a number of plans of private places, public squares and parks, in which there were many points of excellence and much evidence of originality in designing. Photographs of plantations in ground laid out in curved lines, with irregular plantations, indicated that many exotic varieties were used that would not harmonize well with natural plantings.

T. Moehl exhibited 14 plans and illustrations that were very finely executed. They were designs of magnificent castles with formal grounds and were the most important example of this style of gardening. Connected with one of the estates was a park with a simple natural treatment, showing broad unbroken vistas and stretches of turf, skillfully arranged masses of planting, and a simple but evidently fully adequate system of roads.

Ed. Hoppe exhibited 4 plans of private and public grounds in which great skill was shown in the arrangement of the structures and approaches, in the subdivision of the land, and in the arrangement of the plantations.

Rudolphe Kierske exhibited 8 plans.

Carl Oxrt exhibited 17 photographs and 1 plan, the latter a design for a park in Bremen, which was well arranged and nicely executed in oils. The photographs were of planting in the parks of Bremen.

F. von Holt, Denver, Colo., exhibited plans of public grounds in Denver, Colo.

N. J. Rose exhibited 8 designs of places and a number of sketches of trees, etc.

F. X. Hessinger exhibited plans of private places and public grounds.

Berthold Frosch exhibited plans of a public park of Pittsburg which was designed under the direction of E. M. Bigelow, in which were many excellent features.

All the above were in the horticultural building; those in other buildings were not entered for an award and were not examined critically. Of these the finest were exhibited by Eduard Andre, of Paris, France, and by Olmsted, Olmsted & Eliot, of Brookline, Mass.

List of woody plants in the general outdoor competitive exhibits.

Abies alba.
— — aurea.
— — cœrulea.
— Alcockiana.
— — nova.
— amabilis.
— balsamea.
— — pendula.
— brachyphylla.
— Canadensis.
— — atrovirens.
— — macropylla.
— — repanda glauca.
— — Sargentii pendula.
— cephalonica.
— concolor.
— — magnifica.
— — violacea.
— Douglasi.
— — argentea.
— Englemanii.
— excelsa.
— — aurea.
— — conica.
— — Cranstonii.
— — Dicksoni.
— — diffusa.
— — echiniformis.
— — elata.
— — elegans.
— — Ellwangeriana.
— — eremita.
— — Finedonensis.
— — Gregoriana.
— — horizontalis.
— — inversa.

Abies excelsa Maxwelliana nana.
— — monstrosa.
— — mucronata.
— — pendula.
— — procumbens.
— — pumila.
— — pumila glauca.
— — pygmaea.
— — pyramidalis.
— — pyramidalis compacta alba.
— — Remontii.
— Fraseri.
— grandis.
— Hookeriana.
— Kosteriana glauca.
— lasiocarpa.
— Maximowiczii.
— Menziesii.
— Mertensiana.
— Morinda.
— nobilis.
— — glauca.
— Nordmaniana.
— — aurea.
— nigra.
— — Doumetti.
— — pumila.
— — Donana.
— Omorika.
— orientalis.
— Pattoniana.
— pectinata.
— — pendula.
— — pyramidalis.
— Peleponensis.
— pichta.

Abies Pinsapo.
— polita.
— pungens.
— — glauca.
— Schrenkiana.
— Sieboldii.
— Sitchensis.
— Smithiana.
— subalpina.
— Veitchii.
Acer campestris variegatum.
— Colchicum rubrum.
— dasycarpum.
— — crispum.
— — tripartitum.
— — Weirii.
— Japonicum.
— — aconitifolium.
— — macranthum.
— — microphyllum.
— Montpeliensis.
— Negundo argenteum variegatum.
— — aureum variegatum.
— — cissifolium.
— palmatum.
— — latifolium purpureum.
— — sanguineum.
— pictum albo-aureum.
— platanoides Schwedlerii.
— — compacta globosum.
— — Reitenbachii.
— polymorphum atropurpureum.
— — cristatum.
— — dissectum.
— — — atropurpureum.
— — palmatifidum.
— — pendulum.
— — pinnatifidum.
— — reticulatum.
— — roseo-marginatum.
— — roseo-pictis.
— — roseum.
— — sanguineum.
— — sanguineum crispum.
— — sanguineum nigricans.
— — variegatum.
— — versicolor.
— Pseudo-platanus Worlei.
— — atropurpureus.
— — foliis variegatis.
— — leopoldii.
— — lutiscentibus.
— reticulatum.
— saccharinum.
Acer truncatum.
— scolopendrifolium rubrum.
Æsculus Hippocastanum Memmingerii.
— Pavia nana rosea.
Ailanthus glandulosus.
Alnus glutinosa imperialis laciniata.
— — laciniata.
Ampelopsis quinquefolia.
— Veitchii.
Andromeda arborea.
— Japonica.
Aralia Maximowiczii.
Aristolochia Sipho.
Araucaria imbricata.
— Braziliensis.
Aucuba Japonica.
— — crassifolia.
— — fœmina.
— — grandidentata.
— — heterophylla.
— — ilicifolia.
— — limbata.
— — longifolia.
— — macrodantha mascula.
— — macrophylla.
— — maculata.
— — mascula.
— — medio-lutea variegata.
— — nana rotundifolia.
— — salicifolia.
— — variegata.
Azalea, Adelaide.
— Admiral de Ruyter.
— Alba lutea grandiflora.
— Albicans.
— Alphonse de Lavallée.
— Ambroise.
— Amœnissima.
— Anthony Koster.
— Antoinnette.
— Arborea.
— Asa Gray.
— Attila.
— Aurea floribunda.
— Aurora de Roygens.
— Baron Edmund de Rothschild.
— Beauté Celeste.
— Beauté de Flandre.
— Belle Tanette.
— Bijou de Gent crugge.
— Bijou des Amateurs.
— Blondine.
— Bouquet de Flore.
— Bronze Unique.

Azalea Cardinal.
— Cardoniana.
— Charlemagne.
— Charles Baumann.
— Ch. Rogier.
— Chevalier de Reali.
— Chromatella.
— Coccinea.
— Coccinea speciosa.
— Comte de Flandre.
— Comte de Gomer.
— Comte de Quincy.
— Comte Papadapole.
— Comtesse de Kerchove.
— Consul Ceresole.
— Consul Pêcher.
— Cordon.
— Cruenta.
— Cymodocée.
— Daviesi.
— Decus Hortorum.
— Distinction.
— Dominico Scassi.
— Dr. Leon Vignes.
— Dr. Reichenbach.
— Dr. Streiter.
— Duc d'Orleans.
— Dulcinée.
— Ebenezer Pycke.
— Edison.
— Elizabeth.
— Emil Liebig.
— Ernest Bach.
— Esmeralda.
— Eugène.
— Famma.
— Flammeola.
— Flushing Queen.
— Formosa.
— Frans van der Bom.
— Frederick de Merode.
— Frère Orban.
— Fritz Quihou.
— F. T. Seidel.
— Geant des Batailles.
— General Brialmont.
— General Dronot.
— General Franff.
— General Goffinet.
— Glauca stricta.
— Glorie de Belgique.
— Gloria Mundi.
— Graf Alfred von Niaperg.
— Graf von Meran.

Azalea Grand duc de Luxembourg.
— Grande Monarque.
— Grandeur Triomphante.
— Guelder rose.
— Guillaume II.
— Henri Concience.
— Heureuse Surprise.
— Honneur de la Belgique.
— Hortulanus.
— Hugo Koster.
— Ignea nova.
— Isabelle van Houtte.
— Josephine Klinger.
— Julius Cæsar.
— Kissena.
— Knapp Hill Seedlings.
— Leibnitz.
— Lineata Superba.
— Louis Aimée.
— Louis Bonaparte.
— Louis Hellebuyk.
— Madame Legrelle d'Hanis.
— Madame Thiebaud.
— Magnifica albicans.
— Magnificans.
— Marcus Aurelius.
— Margaretha.
— Marie Van Houtte.
— Marie Verschaffelt.
— Mathilda.
— Mélanie.
— Mignon.
— Mina Van Houtte.
— Minerva.
— Mirabilis.
— Mr. Desbois.
— Multiflora.
— Nancy Waterer.
— N. Beets.
— Nero.
— Occidentalis.
— Optima.
— Oswald de Kerchove.
— Pallas.
— Perfecta.
— Perpetua.
— Prince Baudium.
— Prince Budeweiss.
— Prince Guillaume.
— Prince Henri des Pays-Bas.
— Prince of Orange.
— Princesse Adrienne.
— Princesse Charlotte.
— Professor Kirtland.

Azalea Professor Koster.
— Punicea.
— Queen Victoria.
— Raphael de Smet.
— Reine Louise.
— Remarquable.
— Rembrandt.
— Richardii.
— Roi de Belges.
— Roi des Feux.
— Rosea formosissima.
— Rosea lineata.
— Rosea rotundifolia.
— Rose Chérie.
— Rose Marie.
— Rosette.
— Roseum elegans.
— Schiller.
— Sinensis alba grandiflora.
— Souvenir de Louis Van Houtte.
— Triumphant.
— Unique.
— Van Houtte flore pleno.
— Versicolor.
— Versicolor nova.
— Victoria.
— W. E. Gumbleton.
— William Cullen Bryant.
— Wilhelm III.
Bambusa violescens.
Benthamia Japonica.
Berberis vulgaris atropurpurea.
— Aquifolium.
— — fascicularis.
— — heterophylla.
— dulcis compacta.
— — nana.
— Fortunei.
— Japonica.
— — Bealii.
— Neubertii.
— stenophylla.
Betula alba Youngei.
— — atropurpurea.
— — laciniata.
— nana.
— papyracea.
— rotundifolia.
Bignonia radicans.
Biota (or Thuya) orientalis.
— — Defresniana.
— — elegantissima.
— — falcata nana.
— — Japonica.
Biota (or Thuya) Japonica aurea variegata.
— — minima glauca.
— — monstrossa.
— — nana stricta.
— — pyramidalis.
— — — compacta.
— — semperaurea.
— — Zuccariniana.
Bruckenthalia spiculifolia.
Buddlea intermedia.
Buxus Balerica.
— microphylla.
— sempervirens.
— — argentea marginata.
— — aurea.
— — aurea compacta.
— — conica.
— — elegantissima.
— — foliis marginatis.
— — Handisworthii.
— — macrophylla rotundifolia.
— — rotundifolia.
— — — aurea.
— viridis.
Caragana arborescens.
— — pendula.
Carpinus Betulus marginata.
Castanea vesca.
Catalpa speciosa.
— — purpurea.
— syringæfolia aurea.
Ceanothus roseus elegans.
Cedrus Atlantica aurea.
— — Camelie.
— — glauca.
— — pyramidalis.
— Deodara.
— — aurea.
— — crassifolia.
— — variegata.
— Libani pendula.
Celtis occidentalis.
Cephalotaxus Fortunei.
— Drupacea.
Cercis Japonica.
Chionanthus Virginicus.
Clematises:
— Alba.
— Albertine.
— Albert Victor.
— Alexandra.
— Amalia.
— Andre Leroy.

Clematises—Continued.
— Aurealeana.
— Azurea.
— Azurea grandiflora.
— Bangholm Belle.
— Belle d'Orleans.
— Belle Nautaise.
— Bicolor Sieboldii.
— Daniel Deronda.
— Duchess of Edinburg.
— Duchess of Teck.
— Elaine.
— Empress Eugene.
— Emma Margaretha.
— Epiphana.
— Epipharia.
— Etoile de Paris.
— Etoile Violette.
— Eugene Delatre.
— Fairy Queen.
— Faust.
— Florida pallida.
— Fortunatii.
— Fortunei.
— Francois Morrell.
— Fulgens.
— Gigantea.
— Gipsy Queen.
— Glorie de St. Julien.
— Grand Duchess.
— Helena.
— Henrietta de Poligny.
— Henryii.
— Herbert Spencer.
— Hybrida fulgens.
— Hybrida purpurea.
— Hybrida Sieboldii.
— Integrifolia Durandii.
— Iris.
— Jackmanii.
— — alba.
— Jackmanii superbus.
— Jean de Arc.
— John Gould Veitch.
— Juliette Doder.
— Lady Biville.
— Lady Caroline Neville.
— Lady Stralf de Radcliffe.
— La France.
— lanuginosa.
— — Belisaire.
— — candida.
— — nivea.
— — nova.

Clematises—Continued.
— La Mauve.
— Lawsoniana.
— Le Cid.
— Liliana floribunda.
— Lord Beaconsfield.
— Lord Gifford.
— Lord Henry Lenox.
— Lord Mayor.
— Lord Londsborough.
— Lord Napier.
— Lord Neville.
— Louis Van Houtte.
— Lucy Lemoine.
— Madame Baron Veillard.
— Madame Edouard Andrè.
— Madame Elise Schenk.
— Madame Furtado Heine.
— Madame G. Boucher.
— Madame Granger.
— Madame Meline.
— Madame Moser.
— Madame Van Houtte.
— Mademoiselle Torriana.
— Magnifica.
— Marie Brisselot.
— Marie Dessorse.
— Marie Lefebvre.
— Mayflower.
— Max Leitchlin.
— Mrs. Baker.
— Mrs. Cholmondelay.
— Mrs. Kennett.
— Mrs. Howard Vyse.
— Mrs. Le Coultre.
— Mrs. Mary.
— Nelly.
— Nigricans.
— Otto Frœbei
— Patens.
— Paul Avenal.
— Perfecta.
— Perle d'Azure.
— President.
— President Grèvy.
— Prince of Wales.
— Prophetess.
— Proteus.
— Purpurea Elegans.
— Queen Guineveve.
— Ramona.
— Reine Blanche.
— Rendaslerii.
— Rubella.

Clematises—Continued.
— Sophie flore pleno.
— Splendida.
— Standishii.
— Star of India.
— Stella.
— Sylph.
— Symeana.
— The Gem.
— Thomas Moor.
— Thomas Tennett.
— Trobridgensis.
— Undine.
— Uranus.
— Victor Cresole.
— Victoria.
— Victor Lemoine.
— Ville de Paris.
— Vitacella alba.
— — Kermesina.
— — Modesta.
— — Rosea.
— — Rubra grandiflora.
— — Venosa.
— Vitalba purpurea.
— Vitallina purpurea.
— William Kennett.
— Xerxes.
Clethra barbinervis.
Colutea arborescens fl. luteo.
— fl. rubro.
Cornus alternifolia.
— florida rubra.
— — pendula.
— Mas tricolor.
— — variegata.
— paniculata.
— sanguinea.
— — elegantissima.
— — Spathii.
— stolonifera.
Corylus Avellana atropurpurea.
— — aurea.
Cotoneaster microphylla.
Cratægus Carrierei.
— coronaria.
— Crus-galli splendens.
— lucida.
— Oxyacantha fl. rubra. pl.
— — pendula.
— — fl. punicea.
— — fl. alba pl.
— pyracantha Llandii.
Cryptomeria Japonica.
Cryptomeria Japonica compacta.
— — spiralis.
— — viridis.
Cunninghamia Chinensis.
— — glauca.
Cupressus Lawsoniana.
— — alba.
— — — variegata.
— — — spica.
— — — pendula.
— — Allumii.
— — argentea Overeynder.
— — argentea variegata.
— — Bowlerii pendula.
— — compacta.
— — densa.
— — elegans.
— — elegantissima.
— — erecta viridis.
— — filiformis elegans.
— — gracilis.
— — lutea.
— — lutescens.
— — minima.
— — — glauca.
— — monumentalis glauca.
— — nana variegata.
— — patula.
— — pendula.
— — pulcherrima.
— — pyramidalis alba spica.
— — robusta.
— — Rosenthalii.
— — Silver Queen.
— — stricta viridis.
— — — cœrulea.
— — sulphurea.
— — versicolor.
— — viridis.
— — Woorleyi.
— — Youngii.
Cupressus macrocarpa.
— Nutkanus.
— — glauca.
— — pendula.
— thuyoides.
— — variegata.
— — atrovirens.
Cytisus Laburnum.
— — Adamii.
— — semperflorens.
— purpureus.
— — albus.
— scoparius Andreanus.

Cytisus trifoliatus.
Deutzia crenata.
— — candidissima.
— — fl. alba pl.
— — "Pride of Rochester."
— gracilis.
— — argentea variegata.
Dimorphanthus Mandschuricus aureo-marginatus.
— — foliis argenteis variegatis.
Elæagnus longipes.
— Simoni.
Euonymus alatus.
— atropurpureus.
— Europæus.
— — atropurpureus.
— — elatus.
— Japonicus.
— — argentea.
— — Duc d'Anjou.
— — Dux Andegavensis.
— — elegans aurea.
— — elegantissima.
— — flavescens.
— — latimaculata.
— — macrophyllus.
— — — fol. variegatus.
— — marginata alba.
— — — aurea.
— — pulchellus.
— — — variegatus.
— — pyramidalis.
— latifolius.
— myrtifolius.
— radicans.
— — Carrierei.
— — foliis argenteis marginatis.
— — foliis variegata.
Fagus sylvatica atropurpurea.
— — castanæfolia.
— — crispa.
— — heterophylla.
— — laciniata.
— — purpurea pendula.
— — tricolor.
— — variegata.
Forsythia suspensa.
— viridissima variegata.
Fraxinus excelsior.
— — aucubæfolia.
— — aurea.
— — fol. argenteis marginata.
— — fol. aureo marginata.
— — globosa.
Fraxinus excelsior heterophylla.
Glyptostrobus pendula.
Halesia tetraptera.
Hedera Helix arborea.
— — — cardifolia.
— — — maculata.
— — Hibernica.
— — Maderensia.
Hibiscus Syriacus.
— — variegata.
Hippophae rhamnoides.
Hydrangea cordata.
— paniculata grandiflora.
Hypericum Moserianum.
Ilex Aquifolium.
— — argenteum.
— — calamistratum.
— — compactum aureum.
— crenata.
— — variegata.
— — crispa.
— — ferox.
— — — variegata.
— — flammea.
— — — alba.
— — latifolium.
— — laurifolium.
— — marginata grandidentata.
— — nobilis foliis argenteis.
— opaca.
Itea Virginica.
Juglans nigra.
Juniperus Bermudiana.
— Canadensis.
— compressa erecta.
— communis.
— — cracovia.
— — hibernica.
— cupressifolia mas.
— — fœmina.
— drupacea.
— echiniformis.
— excelsa.
— — stricta.
— Fortunei pyramidalis.
— horizontalis.
— Japonica.
— — aurea.
— — — variegata.
— Neaboriensis.
— Oxycedrus.
— pendula viridis.
— Reevesiana.
— rigida.

Juniperus Sabina cupressifolia.
— — variegata.
— — vera.
— Sinensis.
— — alba variegata.
— — aurea.
— — erecta.
— — glauca.
— — mascula.
— Virginiana.
— — Bermudiana.
— — Chamberlainii.
— — elegans.
— — elegantissima.
— — glauca.
— — Schotti.
— — tripartita.
— — Whittmanii.
— Sp. from Japan.
— Sp. Nord de China.
Kalmia latifolia.
Kerria Japonica fl. pl.
— — fol. variegata.
Koelreuteria paniculata.
Ligustrum coriaceum.
— Japonicum excelsum.
— — lucidum.
— — robustum.
— — spicatum.
— ovalifolium tricolor.
— — aureum marginatum.
— Sinensis.
— vulgare.
Liquidamber Styraciflua.
Liriodendron Tulipifera.
— — aurea marginata.
Lonicera brachypoda.
— — Halli.
— Caprifolium.
— — Belgica.
— sempervirens.
— — aurea.
— Tatarica.
Magnolia acuminata.
— alba superba.
— Alexandriana.
— amabilis.
— — nova.
— auriculata.
— cordata.
— grandiflora Nannetensis.
— — Galisonensis.
— hypoleuca.
— Lennei.
Magnolia parviflora.
— reflorescens.
— rustica.
— Soulangeana.
— speciosa.
— — nova.
— stellata.
— Yulan.
Morus Moretti.
— Teas' weeping Mulberry.
Osmanthus ilicifolius.
— — rotundifolius.
Pæonia Moutan.
Periploca Græca.
Phelodendron Amurense.
Philadelphus cordatus.
— coronarius.
— — aureus.
— — Zeyheri.
— — fl. pl.
— dentatus foliis variegatis.
— grandiflorus.
— nivalis.
— speciosus.
Phillyrea latifolia.
— laurifolia.
— longifolia.
Pinus Austriaca.
— Banksiana.
— Canariensis.
— Cembra.
— — Helvetica.
— contorta.
— excelsa.
— flexilis.
— inops.
— monophylla.
— monticola.
— Mughus.
— — pumila.
— Murrayana.
— parviflora.
— Peuce.
— ponderosa.
— — scopulorum.
— resinosa.
— Strobus.
— — compacta nivea.
— — compacta pendula.
— — excelsa.
— — nana.
— — umbraculifera.
— sylvestris.
— — aurea.

Pinus sylvestris densiflora.
— — globosa.
— — Rigaensis.
Platanus orientalis foliis variegatis.
Podocarpus Japonicus.
— Korianus.
Populus alba Bolleana.
— Carolina.
— monolifera.
— — Van Geerti.
— nigra fastigiata.
Prumnophytis elegans.
Prunus Avium fl. pl.
— — fl. rubra pl.
— — pendula.
— Chamæcerasus (as P. pumila).
— — variegata.
— hortensis fl. pl.
— Japonica rosea pendula.
— Laurocerasus.
— — Caucasica.
— — Colchica.
— — crispifolia.
— — Lusitanica.
— — rotundifolia.
— Padus.
— — aurea.
— Pissardi.
— pumila.
— Sinensis fl. rubra pl.
— — fl. pl.
— triloba.
— Virginiana.
— vulgaris purpureis.
— Watereri.
Pseudolarix Kœmpferii.
Ptelea trifoliata.
— — aurea.
Pterostyrax hispidum.
Pyrus angustifolia, Bechtel's Double Flowering Crab.
— Aucuparia pendula.
— baccata floribunda.
— — foliis aureo striata.
— — pendula.
— Japonica.
— — Maulei.
— — Moerloosii.
— quercifolia.
— salicifolia.
— Sorbus Fifeana.
— Toringo.
Quercus Americana magnifica.
— cerris dentata.
Quercus Ilex.
— palustris argentea variegata.
— pectinata.
— pubescens cucullata.
— robur atropurpurea.
— — aurea variegata.
— — concordia.
— — nigrescens.
Retinospora ericoides.
—filifera.
— — aurea.
— leptoclada.
— — Andelyensis.
— lycopodioides.
— obtusa.
— — alba spica.
— — compacta.
— — gracilis.
— — nana.
— — — aurea.
— pisifera aurea.
— — lutescens.
— plumosa.
— — aurea.
— — variegata.
— — viridis.
— squarrosa.
Rhododendron A. B. F. Mitford.
— Abraham Lincoln.
— Adèle.
— Alarm.
— Alba superba.
— Albert Barra.
— Album elegans.
— Album grandiflorum.
— Album perspicuum.
— Album Splendidum.
— Alexander Addie.
— Alexandre Prothere.
— Amilcar.
— Amphion.
— Annica Bricoque.
— Atela.
— Atrococcineum.
— Atrosanguineum.
— Aucubæfolia.
— Auguste van Gaert.
— Aurora.
— Austin Layard.
— Ayrshire.
— Bai Waterer.
— Barclayanum.
— Baron Shroeder.
— Beaumant.

Rhododendron Beranger.
— Bernhard Lauterbach.
— Bertram.
— Bianchi.
— Bicolor.
— Blandyanum.
— Blandyanum superbum.
— Blatteum.
— Boule de Neige.
— Bouquet Royal.
— Broughton.
— Butlerianum.
— B. W. Currie.
— Bylsianum.
— Campanulatum hybridum.
— Candidissimum.
— Candidum.
— Caractacus.
— Catawbiense.
— Catawbiense alba.
— Catawbiense Boursault.
— Catawbiense grandiflorum.
— Celestinum.
— Cetewayo.
— Chameleon.
— Charles Bagley.
— Charles Dickens.
— Charles Fisher.
— Charles Noble.
— Charles Thorold.
— Chionoides.
— Clara.
— Cloe.
— Coerulescens.
— Comte Chas. DeKerkove.
— Comte de Gomer.
— Comptesse de Roquette-Buisson.
— Comptesse Salvi.
— Concessum.
— Concurrent.
— Conspicuum crispum.
— Countesse of Clancarty.
— Countess of Heddington.
— Countess of Wilton.
— Crimson.
— Crown Prince.
— Cruentum.
— Cunninghami.
— Curator.
— Cyaneum.
— Cynthia.
— Delicatissimum.
— Delicatum.
— Diendomie.

Rhododendron Docteur de Mill.
— Docteur Lemoine.
— Doncaster.
— Duc Adolphe de Nassau.
— Duc de Brabant.
— Duc de Cambridge.
— Duc de Malakoff.
— Duchess de Dino.
— Duchesse de Morny.
— Duchess of Bedford.
— Duchess of Connaught.
— Duchess of Sutherland.
— Earl of Shannon.
— Eclipse.
— Edward S. Rand.
— Edwin Landerer.
— Elfride.
— Ellen Cook.
— Emperor Francois Joseph.
— Erectum.
— Etoile des Jardins.
— Evelyn.
— Everestianum.
— Fatuosum fl. pl.
— F. D. Godman.
— Fleur de Marie.
— Florence.
— Flushing.
— Francis Dickson.
— Frau Rosalie Seidel.
— Frederich Hankey.
— Frederick Waterer.
— Garibaldi.
— Gem.
— General Cabrera.
— General Chanzy.
— General Grant.
— General Sherman.
— General Van Sweiter.
— George Cunningham.
— George Paul.
— George Peabody.
— Gloriosum.
— Glymeana.
— Grand Arab.
— Grandiflorum.
— Guido.
— Hayes.
— Hector.
— Helene Schiffner.
— Helen Waterer.
— Herbert Parsons.
— Hippolyte Van de Wolstyne.
— H. W. Sargent.

Rhododendron Iago.
— Jacksoni.
— James Bateman.
— James Macintosh.
— James Marshall Brooks.
— James Mason.
— James Nasmyth.
— J. H. Agnew.
— John Spencer.
— John Walter.
— John Waterer.
— Joseph Whitworth.
— Kaiser Wilhelm.
— Kate Waterer.
— Kathe Mette.
— Kettledrum.
— La Brilliante.
— Lady Annette de Frafford.
— Lady Armstrong.
— Lady Clermont.
— Lady Eleanor Cathcart.
— Lady Francis Crossley.
— Lady Godiva.
— Lady Rolle.
— Lady Strangford.
— Lady Tankerville.
— Lefebvrianum.
— Leoparde.
— Le Porissin.
— Leviathan.
— Lord Derby.
— Lord John Russel.
— Lord Selbourne.
— Lord Wolseley.
— Lorenzo.
— Ludwig Leopold Liebig.
— Maculatum nigrum.
— Maculatum nigrum superbum.
— Madame Carvalho.
— Madame Emile Boyan.
— Madame Faucillon.
— Madame Masson.
— Madame Rosenthal.
— Madame Stetzner.
— Madame Vergeot.
— Madame Wagner.
— Mademoiselle Masson.
— Magnificum.
— Magnum bonum.
— Marchioness of Landsdowne.
— Maroon.
— Marechal Canrobere.
— Marie Stewart.
— Marquise de Pange.

Rhododendron Martin H. Sutton.
— Matchless.
— Melton.
— Memoir.
— Mercator.
— Michael Waterer.
— Minnie.
— Miss Jekyll.
— Monsieur Bertin.
— Monsieur Burella.
— Monsieur Thiers.
— Morion.
— Mrs. Cameron.
— Mrs. Charles Thorold.
— Mrs. Fitzgerald.
— Mrs. Frederick Hankey.
— Mrs. Hemans.
— Mrs. Heneage.
— Mrs. John Clutton.
— Mrs. John Penn.
— Mrs. John Price Lade.
— Mrs. John Watterer.
— Mrs. Mendel.
— Mrs. Mercer Henderson.
— Mrs. Milner.
— Mrs. R. S. Holford.
— Mrs. Shuttleworth.
— Mrs. S. Simpson.
— Mrs. Thomas Agnew.
— Mrs. Thomas Wain.
— Mrs. French.
— Mrs. Walter.
— Mrs. Wm. Agnew.
— Napoleon Baumann.
— Nelly Moser.
— Nero.
— Norma.
— Notabile.
— Octavo Schrijer.
— Odoratum.
— Old Part.
— Omar Pacha.
— Papilionaceum.
— Pelopidas.
— Perfection.
— Perrugino.
— Perryanum.
— Picturatum.
— Ponticum roseum.
— President Joseph Napoleon Baumann.
— Prince Alexander.
— Prince Camille de Rohan.
— Prince Eugene.

Rhodlodendron Prince of Wales.
— Princesse Hortense.
— Princesse Louise.
— Princess Mary of Cambridge.
— Professor Dr. Reichenbach.
— Professor Koch.
— Punctatum rubrum.
— Purity.
— Purpureum crispum.
— Purpureum elegans.
— Quadroona.
— Queen Victoria.
— Raphæl.
— Ralph Sanders.
— René Moser.
— Resuscitator.
— Rt. Hon. Wm. E. Gladstone.
— Rose of Bagshot.
— Roseum elegans.
— Roseum luteum.
— Roseum superbum.
— R. S. Field.
— Rubescens.
— Salmonea rosea.
— Sappho.
— Schiller.
— Scipio.
— Senator Sumner.
— Sidney Herbert.
— Sigismund Rucker.
— Silvio.
— Simon Hevin.
— Sir Chas. Napier.
— Sir John Broughton.
— Sir Robert Peel.
— Sir Thomas Sebright.
— Snowflake.
— Souvenir du Prince d'Orange.
— Star.
— Star of Ascot.
— Star of England.
— Stella.
— Stella Waterer.
— St. Simon.
— Sylph.
— Tamerlane.
— The Queen.
— The Strategist.
— Tippo Sahib.
— Titian.
— Van Dyck.
— Van Houtte.
— Vauban.
— Verschafeltii.
Rhodlodendron Vesuvius.
— Victoria.
— Village Maid.
— Vivian Grey.
— Vivid.
— Voltaire.
— Von Siebold.
— Warrior.
— Wm. Austin.
— William Cowper.
— William Milton.
— Zampa.
Rhus Cotinus.
— glabra laciniata.
Rhodotypos kerrioides.
Ribes floridum.
— Lobbi.
— sanguineum.
Rosa rugosa.
— Wichuraiana.
[Also many garden varieties. See p. 113.]
Salisburia adiantifolia.
Salix Americana nigra pendula.
— alba.
— — regalis.
— — vitellina aurantiaca.
— Babylonica.
— — Salmoni.
— Capræa pendula.
— — tricolor.
— herbacea.
— palmæfolia.
— retusa.
— rosmarinifolia.
— Sieboldii.
Sambucus nigra aurea.
— — laciniata.
— — pulverulenta.
Sciadopytis verticillata.
Sequoia gigantea.
— — pendula.
— sempervirens.
Skimmia fragrans.
— Japonica.
Spiræa ariæfolia.
— Billardi.
— callosa.
— — alba.
— — Bumalda.
— — crispifolia.
— — semperflorens.
— Fontenaysi.
— — alba.
— Lindleyana.

Spiræa luxuriosa.
— opulifolia.
— — aurea.
— prunifolia fl. pl.
— Reevesiana.
— — fl. pl.
— rotundifolia.
— salicifolia.
— Thunbergii.
Staphylea Colchica.
Sterculia platanifolia.
Styrax Americana.
— Japonica.
Syringa dubia.
— Josikæa.
— ligustrina pendula.
— Persica.
— — alba.
— — Pierre Blanc.
— Sinensis Sanguinea rosea.
— — Rothomagensis.
— villosa.
— vulgaris.
— — Charles X.
— — gigantea.
— — Marie Legraye.
— — nana.
— — Rubra de Marley.
— — Ville de Troyes.
— — virginalis.
— — — grandiflora.
Tamarix Africana.
Taxodium distichum.
Taxus baccata.
— — aurea.
— — aurea marginata.
— — Dovastonii aurea variegata.
— — elegantissima.
— — erecta.
— — fastigiata Dovastonii.
— — fructu luteo.
— — Hibernica variegata alba.
— — — variegata aurea.
— — — aurea nova.
— — imperialis.
— — major.
— — Washingtonii.
— Canadensis.
Thuya gigantea.
— — atrovirens.
— — aurescens.
— — semperaurea.
— occidentalis.
— — alba.
Thuya occidentalis argentea.
— — aurea.
— — Boothi.
— — Caucasica.
— — Columbia.
— — compacta.
— — conica.
— — Douglas' golden.
— — — pyramidal.
— — Ellwangeriana.
— — ericoides.
— — glauca.
— — globosa.
— — Hoveyii.
— — pendula.
— — pumila.
— — pyramidalis.
— — Queen Victoria.
— — Siberica.
— — Tom Thumb.
— — variegata.
— — Verveneana.
Thuyopsis borealis.
— — argentea.
— — compacta.
— — glauca.
— dolabrata.
— — variegata.
— laetivirens.
Tilia Americana.
— dasystyla.
— Europæa.
— — laciniata rubra.
— — alba spectabilis.
Torreya myristica.
— nucifera.
Ulmus Americana.
— — gigantea.
— campestris corylifolia nigrescens.
— — Dampierii.
— — — aurea.
— — foliis variegatis.
— — Louis Van Houtte.
— — memorie Louis Van Houtte.
— — monumentalis.
— — purpurea.
— — pyramadalis.
— — variegata argentea.
— montana Camperdownii.
— sativa foliis variegatis.
— umbraculifera.
Viburnum dentatum.
— dilatatum.
— Japonicum Sieboldii.

Viburnum Japonicum Sieboldii variegatum.
— Lantana.
— Lentago.
— Opulus.
— — sterilis.
— plicatum.
— Tinus.
Vitis heterophylla variegata.
Weigela Abel Carriere.
Weigela amabilis foliis variegatis.
— hortensis alba nivea.
— Mons. Lemoine.
— nana variegata.
— P. Duchartre.
— rosea.
— Voltaire.
Wistaria frutescens.
— Sinensis.

Perennial herbs on exhibition, in the open, at the World's Fair.

Acanthus latifolius.
Achillea Ægyptiaca.
— Millefolium roseum.
— ptarmica fl. pl.
— — The Pearl.
— tomentosa.
Aconitum Fischerii.
— Napellus.
— — bicolor.
Acorus Calamus variegata.
Ægipodium podograria variegata.
Agrostemma (Lychnis) coronaria.
— — alba.
Ajuga Genevensis.
— pyramidalis.
— reptans variegata.
— — alba.
Alchemilla alpina.
Alstrœmeria aurantiaca.
Alyssum saxatile compacta.
Androsace sarmentosa.
Anemone Japonica.
— — alba.
— Pennsylvanica.
— sylvestris.
Anthemis tinctoria.
— — alba.
Anthericum Liliago major.
Aquilegia Californica hybrida.
— Canadensis.
— chrysantha.
— glandulosa.
— Skinneri.
— vulgaris fl. pl.
— Sternbergia.
Armeria cephalotes.
— — rosea.
— formosa.
— maritima.
— — alba.
— plantaginea.
Artemisia Ludoviciana.
— Pontica.
Arundinaria variegata.
Arundo Donax.
— — variegata.
Aspidium Lonchitis.
— viridis.
Asplenium Trichomanes.
Aster alpinus.
— Amellus Bessarbicus.
— Belgica, Lady Trevelyn.
— Chapmanii.
— formosissima.
— Lindleyana.
— longifolia subsessilis.
— Novæ-Angliæ.
— — rubra.
— ptarmicoides.
Astrantia Carniolica.
Aubrietia Eyrei.
— Græca.
— violacea.
Auricula in variety.
Baptisia australis.
— leucophæa.
Barbarea vulgaris foliis variegatis.
Bellis perrenis.
Boltonia asteroides.
— glastifolia.
— grandiflora.
— latisquama.
Callirhoë involucrata.
Campanula Carpatica.
— glomerata Dahurica.
— Mariesii.
— media in variety.
— persicifolia.
— — alba.
— — — plena.
— rotundifolia.
— Scheuchzeri.

Cassia Marilandica.
Catananche cœrulea in variety.
Centaurea montana.
Chrysanthemum Golden Fleece.
Chrysosplenium oppositifolium.
Clematis Davidiana.
— paniculata.
— stans.
Coreopsis grandiflora.
— lanceolata.
— rosea.
— verticillata.
Cystopteris fragilis.
— regia.
Delphinium Belladona.
— Bicolor grandiflora.
— Copperie.
— densiflorum.
— Gen. Ulrich.
— Heinmanii.
— imbricatum cœlestinum.
— La Lorraine.
— Lord Mayor.
— Magnetine.
— magnificum.
— Sinensis in variety.
— — grandiflorum.
— — cœruleum.
— — album.
Desmodium penduliflorum.
Dianthus barbatus in variety.
— Caryophyllus in variety.
— Emperor.
— dentatus.
— Hispanicus.
— plumarius.
— — albus.
— — semperflorens.
Dicentra eximea.
— spectabilis.
Dictamnus Fraxinella.
— — alba.
Digitalis gloxinoides.
— — alba.
— — purpurea.
Doronicum Caucasicum.
— Clusii.
Echinops Ritro.
Elymus giganteus.
— glaucus.
Erigeron speciosum.
Erinus alpinus.
Eryngium amethystinum.
— purpureum.
Eulalia Japonica.
— — gracillima.
— variegata.
— — zebrina.
Eupatorium Fraserii.
Euphorbia corollata.
— Myrsinites.
Funkia grandiflora.
— lanceolata.
— ovata.
— Sieboldii albo-marginata.
— undulata variegata.
Gaillardia grandiflora.
Geranium cinereum.
— maculatum plenum.
— platyphillum.
Geum miniatum.
Glechoma hederacea variegata.
Gypsophila paniculata.
Helenium autumnale.
— pumilum.
Helianthus decapetalus.
— Japonicus.
— laetiflorus.
— Maximilianus.
— mollis.
— — grandiflorus.
— multiflorus.
— — plenus.
— orgyalis.
— rigidus.
— — præcox.
— — semperflorens.
Heliopsis lævis.
— Pitcheriana.
Hemerocallis disticha fl. pl.
— flava.
— fulva.
— — plena.
— gramineus.
— Kwanso.
— — fl. pl.
— Muldendorfi.
— rutilans.
Heuchera sanguinea.
Hibiscus Californicus.
— incanus.
— militaris.
— Moscheutos albus.
— — Crimson Eye.
— roseus in variety.
Humulus Thunbergii.
Iberis cordifolia.
— semperflorens.

Iberis sempervirens fl. pl.
Iris Caroliniana.
— cristata.
— cuprea.
— Germanica Mad. Chereau.
— Kœmpferii in variety.
— neglecta Fairy Queen.
— odoratissima.
— Olbiensis atrocœrulea.
— pumila.
— squallida.
— Siberica.
— — hematophylla.
— — orientalis.
— — plena.
— — sanguina.
— variegata Orpheon.
— — Apollon.
Lathyrus latifolius.
— — albus.
Lepachys pinnata.
Liatris scariosa.
— spicata.
Lillium auratum.
— — macranthum.
— — vittatum.
— — virginale alba.
— Batemanii.
— Colchicum Scovitzianum.
— Columbianum.
— concolor.
— cordifolium giganteum.
— coridion.
— elegans Alice Wilson.
— — fl. pl.
— — incomparable.
— — rubra plena.
— Hansonii.
— Japonicum odoratum.
— Kramerii.
— lancifolium.
— — album.
— — rubrum.
— Leichtlinii.
— — rubrum.
— longiflorum.
— — eximeum.
— — folis marginatum.
— Martagon.
— superbum.
— tenuifolium.
— testaceum.
— tigrinum.
— — fl. pl.
Lillium splendens.
Linum perenne.
Lobelia splendens in variety.
— syphilitica.
— — alba.
Lotus corniculatus.
Lychnis Chalcedonica.
— — alba.
— flos cuculi alba pl.
— vescaria fl. pl.
— vespertina fl. pl.
Malva alcea.
— — alba.
— moschata.
Melandrium Zawadskyi.
Mentha arvensis.
— piperita, Black Mitcham.
— — White Mitcham.
— viridis.
Monarda didyma.
— — alba.
— — coccinea.
— fistulosa.
Montbretia crocosmiflora.
Myosotis palustris semperflorens.
Nelumbium album grandiflorum.
— speciosum.
Nymphæa Breakleyi rosea.
— — candidissima.
— dentata.
— Devoniensis.
— gracilis.
— Laydeckeri rosea.
— Marliacea.
— — albida.
— — carnea.
— — chromatella.
— — rosea.
— rubra.
— odorata sulphurea.
— pygmæa.
— pygmæa helveola.
— Sturtevantii.
— Zanzibarensis.
— — azurea.
— — rosea.
— — superba.
Œnothera fruticosa magnifica.
— riparia.
— Youngii.
Opunita Missouriensis.
Pæonias in variety.
Pachysandra terminalis.
Papaver nudicaule.

Papaver nudicaule Royal Scarlet.
— — Salmon Queen.
— orientale.
— — bracteata.
— — immaculata.
— — Little Prince.
— — maxima.
— — Parkmanii.
— — Prince of Orange.
Pardanthus Chinensis.
Pentstemon barbatus Torreyii.
— diffusus.
— digitalis.
— lævigatus.
Phlox amoena.
— bifida.
— Carolina.
— ovata.
— paniculata.
— reptans.
— Stellaria.
— subulata.
— — alba.
— suffruticosa.
Phloxes, garden varieties.
— Adolph Wick.
— Alexander Von Humboldt.
— Andrew Keddie.
— Annie Vibert.
— Arago.
— Atlas.
— Auguste Rivière.
— Baron de Lassus.
— Beauty of Mindon.
— Beauty of Mirande.
— Beckey.
— Boule de Feu.
— Boule Hely.
— Boule de Neige.
— Bridesmaid.
— Burns.
— Caleope.
— Cameron.
— Carot.
— Charlemagne.
— Chimene.
— Clara.
— Claude de Jouffroy.
— Coccinea.
— Colonel Flatterer.
— Comedie.
— Compte de Brow.
— Croix de Honneur.
— Compte Lambertye.
Phloxes, Crozy Fils.
— Cuirassé.
— De Fonvielle.
— De Lesseps.
— Delicatum.
— Dr. Crévaux.
— Earl of Rosslyn.
— Erato.
— Ernest Benary.
— Eugene Verdier.
— Figaro.
— Fraulein Steiner.
— Geanne de Arc.
— General Marguerite.
— George Sand.
— George Weyness.
— Glorie de Orleans.
— Gloria Victis.
— Henri Bryon.
— Henri Draison.
— Henry Liernae.
— Horace Vernet.
— Hyphinison.
— John Alexander.
— J. Stewart.
— Le Jeune Viala.
— Le Patriote.
— la Vagne.
— Ledarlur.
— Le Pole Nord.
— Liervalli.
— Lord Byron.
— Mad. Bardon.
— Madame de Massoncure.
— Madame de St. Pulgent.
— Madame H. Jacotot.
— Mad. J. Coste.
— Mad. Moisette.
— Mad. Prosper Sangiers.
— Mad. Randatler.
— Mad. Verlot.
— Mlle. de Roland.
— Mlle. Sousine.
— Margaretha.
— Miss Lingard.
— Mr. Arnold Tournier.
— Mrs. Arberdeen.
— Mrs. Eldèr.
— Mrs. Gardiner.
— Mrs. Goodwin.
— Mrs. James Anderson.
— Mrs. Laing.
— Mrs. Tennant.
— Mrs. Whitehead.

Phloxes, Mons. Aubry.
— M. Graham.
— M. Guilbert.
— M. Oudin.
— Pelleton.
— Pierre Lierval.
— Pionnier.
— Princess of Wales.
— Princess Ghykze.
— Princess Louise.
— Princess Louise Lorne.
— Progress.
— Purple gem.
— Richard Wallace.
— Roi Marshall.
— Rubra splendida.
— Souvenir de Enfant.
— Souvenir de Nancy.
— St. Beauve.
— Talisman.
— Telephone.
— T. Granger.
— The Deacon.
— The Pearl.
— The Queen.
— Victor Hugo.
— Zebra.
Phyteuma Scheuchzerii.
Platycodon grandiflorus.
Plumbago Larpentæ.
Polemonium.
— coeruleum.
— — album.
— reptans.
— Richardsonii.
Polygonum amplexicaule.
— cuspidatum.
— — crispum.
— Sachalinense.
Pontederia crassipes.
Potentilla aurea.
— Glorie D' Nancy.
— Jane Salter.
— La Versuve.
— Wm. Robinson.
Poterium Canadensi
Primula. stachys.
— auriculata alli.
— hirsuta. a.
— minimiosa.
Pyrethrums arvensis.
— Aium Convolvulus.
— im Dulcamara.
Hibiscus Trionum.

Pyrethrums, Aphrodite.
— Aquilla.
— Argentine.
— Aurora.
— Balventius.
— Bates.
— Beatrice.
— Bicolor grandiflora.
— Boecace.
— Bon Ami.
— Bridesmaid.
— Candidum plenum.
— Capt. Nares.
— Celia.
— Copperie.
— Delicatissinum.
— Densiflorum.
— Desse.
— Eugene.
— Flora.
— Galopin.
— Gazelle.
— Gaubanberg.
— Glen Ulrich.
— Gloire d'Italie.
— Glow Worm. na.
— Godiva. ia.
— Golfatene.
— Grandiflora
— Gustav H a.
— Heinema lata.
— Henry oselero sylvestre.)
— Hymen is.
— Imbr obilis.
pat. a (Smilax.)
necio elegans.
Spiræa canescens?
— Reevesiana.
Swainsonia Osborni.
Tabernæmontana albiflora.
Tachira fatuosa.
Taxodium distichum.
Thuyopsis dolabrata.
Volkameria fragrans.

eds in the exhibit of the Orange Judd Farmer.

Echium vulgare.
Eupatorium perfoliatum.
Saponaria officinalis.
Arctium Lappa.
Cenchrus tribuloides.
Ranunculus bulbosus.
Diodia teres.
Mollugo verticillata.

Pyrethrums, Penelope.
— Princess of Wales.
— Queen of May.
— Raphana.
— Roland.
— Roseum.
— Rosy Morn.
— Spectabile.
— Talina.
— Uliginosum.
— Uz...
— — ciliata.
— — cordifolia.
— — — purpurea.
— sancta.
Scabiosa Caucasica.
Scirpus Taber...
Sedum Anac...
— S...
— subula...
— — alba.
— suffruticosa.
Phloxes, garden va.
— Adolph Wick.
— Alexander Von H...
— Andrew Keddie.
— Annie Vibert.
— Arago.
— Atlas.
— Auguste Rivière.
— Baron de Lassus.
— Beauty of Mindon.
— Beauty of Mirande.
— Beckey.
— Boule de Feu.
— Boule Hely.
— Boule de Neige.
— Bridesmaid.
— Burns.
— Caleope.
— Cameron.
— Carot.
— Charlemagne.
— Chimene.
— Clara.
— Claude de Jouffroy.
— Coccinea.
— Colonel Flatterer.
— Comedie.
— Compte de Brow.
— Croix de Honneur.
— Compte Lambertye.

Sempervivum.
— angustifolium.
— arachnideum.
— patens.
Silene ciliata.
— Schafta.
Silphium perfoliatum.
Soldanella montana.
Spiræa Aruncus.
— astilboides.
— Filipendula.
— — pl.
— Japonica.
— — foliis variegatis.
— — grandiflora.
...lobata.
...is.
...a.
...is variegatis.
...ifolia.
Stellaria Holostea.
Stokesia cyanea.
Stylophorum diphyllum.
Tolmiea cardinalis.
Tradescantia pilosa.
— Virginica.
— — alba.
...r.
— Lord...
— La ...
— Lord...
— Madam...
— Mad. Bo...
— Mad. ...
— Ma...
...icum.
T...
T...
...ssilis.
— M...
— Mlle. ...
— Mlle. So...
— Margareth.
— Miss Lingard.
— Mr. Arnold T...
— Mrs. Arberdeen.
— Mrs. Eldèr.
— Mrs. Gardiner.
— Mrs. Goodwin.
— Mrs. James Anderson.
— Mrs. Laing.
— Mrs. Tennant.
— Mrs. Whitehead.

The Mexican nursery exhibit in the Midway Plaisance, so far as the species or trade names were determinable.

Adiantum sp.
Anthurium acaule.
— cordifolium.
— lancifolium.
— longifolium.
— pinnatifidum.
Aphelandra Liboniana.
Aralia denticulata.
Ardisia Mexicana.
Begonia nivea.
— punctata.
— ricinifolia.
— sanguinea.
— semperflorens.
Bæria ovellana.
Bescharneria yuccoides.
Briophyllum epilepticum.
Buddleia globoso.
Caffea Arabica.
Canna Indica.
Carica Papaya.
Cestrum coccineum.
Chinchona.
Cibotium nigrum.
— Schiedei.
Citrosma limoncillo.
Citrus Aurantium.
— — Mandarin.
— myrtifolia.
Cuphea Cavendishi.
Cupressus Benthamiana.
Dasylerion serratifolium.
Datura arborea.
Dioon edule.
Echeveria.
Felicia Mexicana.
Ficus angustifolia.
— Castilloa.
— eburnea.
Fuchsia longifolia.
Geonoma Verschaffeltii.
Guatteria sp.
Hæmatoxylon Campechianium.
Hibiscus Chinensis.
Inga pulcherrima.
Jambosa vulgaris.
Juglans Mexicana.
Juniperus Virginiana.
Justicia carnosa,
— labia.
— pictorea.
Lagerstrœmia Indica.
Ligustrum ovalifolium.
Macrozamia Mexicana.
Muraltia limonaria.
Musa zebrina.
Myrtus sp.
Pachira fastuosa.
Panax cordifolium.
Philodendron sp.
Phyllocactus sp.
Pinus leiophylla.
— religiosa.
Poinsettia pulcherrima.
Psidium Guadalupia.
— Guyava.
Pteris serrulata.
Quercus repanda.
Ribes campanulata.
— wild (Groselero sylvestre.)
Rivina humilis.
Sanchezia nobilis.
Sarsaparilla (Smilax.)
Senecio elegans.
Spiræa canescens?
— Reevesiana.
Swainsonia Osborni.
Tabernæmontana albiflora.
Tachira fatuosa.
Taxodium distichum.
Thuyopsis dolabrata.
Volkameria fragrans.

Weeds in the exhibit of the Orange Judd Farmer.

Amarantus chlorostachys.
Panicum Crus-galli.
Apios tube rosa.
Bidens frondosa.
Convolvulus arvensis.
Polygonum Convolvulus.
Solanum Dulcamara.
Hibiscus Trionum.
Echium vulgare.
Eupatorium perfoliatum.
Saponaria officinalis.
Arctium Lappa.
Cenchrus tribuloides.
Ranunculus bulbosus.
Diodia teres.
Mollugo verticillata.

Daucus Carota.
Nepeta Cataria.
Anthemis arvensis.
Brassica Sinapistrum.
Bromus secalinus.
Cerastium arvense.
Chicorium Intybus,
Xanthium spinosum.
Melilotus officinalis.
Xanthium Canadense.
Silphium laciniatum.
Rudbeckia hirta.
Agrostemma Githago.
Panicum sanguinale.
Rumex obtusifolius.
— crispus.
Silphium terebinthinaceum.
Apocynum cannabinum.
Erechthites hieracifolia.
Potentilla Canadensis.
Erigeron annuus.
— ramosus.
Chamæraphis glauca.
— viridis.
Solidago Canadense.
— lanceolata.
— rigida.
Chenopodium album.
Physalis Virginiana.
Hieracium aurantiacum.
Brunella vulgaris.
Vernonia fasciculata.
— Noveborascensis.
Cynoglossum officinale.
Erigeron Canadense.
Lycopus Europeus.
Lactuca Scariola.
— Canadensis.
Malva rotundifolia.
Passiflora incarnata.
Maruta Cotula.
Melilotus albus.
Asclepias Syriaca.
Monarda punctata.
Pucnanthemum lanceolatum.
Ipomea hederaceus.
Leonorus Cardiacus.
Verbascum Thapsus.
— Blattaria.
Brassica nigra.
Sisymbrium officinale.
Veronica arvensis.
Stachys palustris.
Solanum nigrum.
Medicago lupulina.
Pastinaca sativa.
Cassia Chamæcrista.
Thlaspi arvense.
Hedeoma pulegioides.
Lepidium Virginicum.
— campestre.
Amarantus retroflexus.
— paniculatus.
Plantago major.
— Rugelii.
Phytolacca decandra.
Œnothera biennis.
Portulaca oleracea.
Agropyrum repens.
Raphanus Raphanistrum.
Ambrosia artemisifolia.
— trifida.
Plantago lanceolata.
Elymus Canadensis.
Saxifraga Pennsylvanica.
Capsella Bursa-pastoris.
Polygonum incarnatum.
— Pennsylvanicum.
Eryngium yuccafolium.
Rumex Aceticella.
Bidens bipinnata.
Euphorbia Preslii.
— maculata.
Hordeum jubatum.
Echinospermum Lappula
Erodium cicutarium.
Helianthus strumosus.
Dipsacus sylvestris.
Cirsium arvense.
— lanceolatum.
Sonchus oleraceus.
Datura Stramonium.
— Tatula.
Linaria vulgaris.
Tecoma radicans.
Amarantus albus.
Abutilon Avicennæ.
Verbena urticifolia.
— hastata.
Panicum capillare.
Achillea Millefolium.
Barbarea vulgaris.
Oxalis stricta.
Camelina sativa.

SEEDS, SEED RAISING, TESTING, AND DISTRIBUTION.

By Dr. L. WITTMARK *Professor at the University and at the Royal Agricultural High School at Berlin, Geheimen Regierungsrath, Judge at Chicago.*

HISTORY.

Seed raising as a business was for a long time the privilege of certain ancient garden cities, especially in Germany, where Erfurt may be cited, perhaps, as the ancestor of all seed-growing places, and in France, where the house Vilmorin, Andrieux et Cie, Paris, existed in in its founder, Pierre Andrieux, already in 1745. But even in Germany and France it is scarcely one hundred years ago that the commerce with seeds began on a larger scale, and the true progress must be dated from the time of railroads and steamships. In Great Britain, in Austria, and other countries of the old continent, it is nearly the same; nowhere seed growing on a large scale is older than about one hundred years, and in Italy and the Riviera, where now there exist so many seed firms, it counts scarcely forty years; in Denmark, now also very reputed, still less.

The United States, therefore, has not to complain too much when it is said that before 1830 there were in the United States very few seedsmen; their seed raising is not much younger than in many parts of the Old World. But, like in many countries of the latter, the American great seed growers of modern times have advanced their business in such a high manner that they are, in many respects, equal to their colleagues of the old continent, or even surpass them in quantity of some products.

DIVISION OF LABOR, DIFFERENT LOCALITIES.

The principle of our time, "division of labor," is also the motto in seed raising. Each seed is grown in best quality in certain places; nobody can grow all at one place, and the intelligent seed grower, therefore, will only produce those seeds himself which he can bring to their greatest perfection, the others he will have grown by his contractors or he will buy them. The United States, with its vast area, its different climate, its different soil, nearly offers special localities for every seed. Beans, peas, and turnips produce best grains in the northwestern part of New York and the adjoining region of Canada,

beans also in California, watermelons in the damp, rich soil of Florida, muskmelon, cucumbers, and squashes in New Jersey and Nebraska, eggplants in New Jersey and Georgia, onions in Connecticut and California, tomatoes in Pennsylvania, Ohio, and California, lettuce and cauliflower in California, cabbage in Bucks County, Pa., and Long Island, etc.[a]

Flower seeds are not grown so much in North America as in Europe, because of the high price of labor, but balsams, salvias, zinnias, mignonette, petunias, and last, but not least, sweet peas, are grown by some of the greatest seedsmen with the aim of getting the highest perfection.[b] So it is done at Fordhook, near Doylestown, Bucks County, Pa., the seed farm of W. Atlee Burpee & Co., Philadelphia; so at Hackensack, the farm of Peter Henderson & Co., and so with many others, every one often having still his peculiar specialty.

Besides the different soils and climates there is another factor which makes North America so well qualified for seed raising; that is the dry summer, which ripens the seeds so well, and the fair harvesting weather, which facilitates collecting the seeds in good condition. Dry summers are also in France, especially in the south of France, and in Italy, but fortunately often also in the center of Germany.

Only some grains seem to like a moist climate. Thus the cauliflower, at least one variety, the Early Dwarf Erfurt, which is now not only grown at Erfurt, in Germany, but also to a great extent in Denmark. Mr. T. Pedersen-Bjergaard, of Copenhagen, who read a paper on Seed Growing in Denmark at the horticultural congress of Chicago, 1893, expresses the opinion that the excellent quality of this seed in Denmark is probably mainly due to the high northern latitude of the country, the near proximity of the salt water, and the comparatively moist and cool state of the atmosphere.[c]

TESTING.

The seedsman must not only be a good merchant in order to overlook the condition of the market, present and future, but he must also be a connoisseur. He must be able to judge the different samples offered, and therefore must have a good knowledge of the minute differences in seeds which resemble one another. But in many cases it is impossible to judge from the external appearance; the seeds of the different types of beets, cabbage, etc., often look quite the same; nay, it is even not always possible to distinguish the grain of

[a] W. Atlee Burpee & Co., Philadelphia, Selection in Seed Growing, embracing papers read at the World's Horticultural Congress at Chicago, 1893, on modern methods of the seed trade, seed growing at Fordhook Farm, p. 86. (We shall cite this valuable book briefly as Selection in Seed Growing.)

[b] C. S. Allen, modern methods of the seed trade in Selection in Seed Growing, p. 67.

[c] Selection in Seed Growing, p. 32.

the oil-giving rape seed from that of the turnip. For testing such seeds and for many other purposes, the seedsman must have trial grounds. Here he can grow all the seeds of his contractors, and see who furnishes the best; here he can also grow seeds of his competitors, and here he can learn the comparative merits of novelties.[a] Messrs. W. Atlee Burpee & Co., Philadelphia, to whom I am indebted for much information, have at their seed farm at Fordhook, which contains 120 acres, devoted 14 acres in 1894 to trial grounds, where 6,722 tests were made. A good description with illustration is given in The Florists' Exchange, New York, 1894, page 834.

Testing the germinative power of seeds is another object of the seedsman in Germany and also France. Nearly all greater seedsmen of agricultural seeds have placed themselves under the control of the seed-control stations, mostly combined with agricultural experiment stations. In the shows of the great German agricultural societies it is required that seeds which will compete must have been taken out of a large quantity before witnesses and have been sent by the exposition committee, long before the exposition, to a seed-control station. That is the only way for the judge to be sure he does not get a small quantity especially prepared for the exposition.

NOVELTIES AND METHODS OF GAINING THEM.

The desire for novelties is one of the best means of promoting seed growing and of advancing the standard in the varieties, but it brings discredit to the seedsman if he furnishes seeds of novelties which afterwards prove to be a failure. One should be scrupulous in testing novelties and in bringing them into commerce. The seedsmen should confine themselves to a wise restriction, as the number of novelties appearing every year in the trade is too great. How are novelties gained? The answer to this question gives one the best idea of the varied systems a seedsman has to adopt. Like the great importers of plants, some seed houses have travelers in foreign countries who send seeds of plants not yet introduced. These give novelties of the greatest merit in botanical and even in horticultural respects, and in this way true new species or even new genera are introduced. Another way, open to everybody, even to those who can not sacrifice thousands for travelers, is that of selecting new forms out of old plants, and this is the chief object of our seed growers; this is the way to advance horticulture in the most eminent degree. It seems very simple to select a new form, but it is much more difficult than one might imagine. It requires, first, a knowledge of the varieties already existing; secondly, a constantly watchfulness; thirdly, great pains in

[a] See "American seed growing" by C. C. Morse, "The seedsman's trial grounds," by W. Atlee Burpee, "Modern methods of the seed trade," by C. S. Allen, all in W. Atlee Burpee, Selection in Seed Growing, pp. 34, 41, 60.

propagating and fixing the new form found. But the keen seed grower is not satisfied to select only new forms which an accident or perhaps unknown circumstances have caused. He will produce new forms artificially, and this is by hybridization. Here the greatest skill is necessary and the highest triumphs may be achieved, as we see in the hybrid gladioli, the begonias, the carnation, the petunia, the potatoes, the chrysanthemum, etc. However, in both cases, in simple selection or in crossing, the grower can only hope to get a good result if one great factor will assist him; that is, heredity. Mr. Henri L. de Vilmorin, of the far-famed house of Vilmorin, Andrieux & Cie., Paris, has demonstrated that in the most thorough manner in his paper on "Pedigree or grade races in horticulture," read before the seedsmen's session of the World's Fair horticultural congress, Chicago, August 17, 1893.[a] He has shown what heredity is, how it works, and how the action of heredity can best be turned to account. And Mr. C. L. Allen, New York, in that same session, has clearly proved in his paper on "Selection in its relations to seed growing" the importance of this way for getting new forms. But he has also pointed out that the seedsman in the vast country of the United States, where the setting sun of the East is the rising sun of the West—where climate and soil are so different—has much more trouble than a seedsman in other countries. He must have a knowledge of selection sufficient to enable him to choose from (we would add, and for) every section of country such types as are best adapted to its various conditions of climate and soil.

DISTRIBUTION.

The distribution of seeds has made enormous progress, since the Universal Postal Union embraces nearly all countries of the world: from the old continent to the new, and vice versa, thousands and thousands of "samples without value," but registered, cross the ocean: samples which often have a great value, but which otherwise sent by freight would take double the time for their transport. Also in the single countries the low tariffs of the postage have helped very much for a greater distribution of catalogues and seeds. The catalogues are the pioneer of the seedsman and the first condition of getting a wide distribution for seeds. It is almost incredible, and yet true, to hear in which numbers some houses send out catalogues. Vilmorin, Andrieux & Cie., Paris, send out their main price list in more than 100,000 copies yearly; W. Atlee Burpee & Co., Philadelphia, of their five different catalogues together, 575,000, in addition to some millions of circulars. The expert seed growers together send out 2,000,000 catalogues; F. C. Heinemann alone 135,000, and 500,000 to 1,000,000 of prospects; T. C. Schmidt, 250,000, and 1,000,000 prospects; Haage & Schmidt.

[a] Selection in Seed Growing, p. 10.

50,000 voluminous catalogues, etc. The facilities in distribution by the post, which in Germany also transports packages, so that no express companies are necessary, have had still another influence. Formerly there was a great difference between wholesale and retail seed businesses. This difference has somewhat diminished, and some great firms mostly sell directly to private customers. There are only a few who do not do so. Messrs. Ernst Benary, Erfurt; Gebrüder Dippe, Quedlinburg; Haage & Schmidt, express (partly). Nevertheless, there remains room for smaller business in every town, and if these concentrate themselves on some specialties which they have in the best quality possible, they will always have prosperous business. Generally smaller firms also are dealers in garden implements, manures, etc.

Some large firms have agents in other places, and these furnish the seeds in the same good quality as the firm itself. But there is another class of people who often do damage to the real trade. These are the peddlers who go about in the villages, in the small farms, and sell to the believing farmers, under great promises, their inferior seeds as well as inferior fruit trees.

Another means for getting customers are the shop windows of the retail seedsman. The shops in the United States must be named first, as perhaps nowhere is such good display to be seen as there. Seeds in all colors, bulbs, tubers, chromolithographic plates, etc., all arranged in a tasteful manner, will certainly not fail to attract the attention of the public, the more so as a good deal is exposed on the sidewalks. As to the distribution itself, nearly all seed houses have similar arrangements. Each usually has several departments—a flower seed, a vegetable seed, a grass seed, a bulb, a potato department, and so on. For the flower seeds pigeonholes and small drawers; for larger seeds, such as sweet peas, large bins are used. The chief aim is to prepare all during the slack time of the year for the few months of the growing season. Thousands and thousands of small packages have to be made, and fortunately the little paper bags are now made in special manufactories at a very low price. The seedsman has "only" to fill them; but this word "only" requires a great deal of time and a great many hands. Therefore, it is to be welcomed as a great progress that Messrs. W. Atlee Burpee & Co., Philadelphia, have an automatic package filler and closer, worked by steam.[a] The paper bags, of which all the small sizes can be used, are placed in a horizontal rack, along which they move in an erect position; the seed is poured into a hopper at the top of the machine, which is then started. With wonderful rapidity a scoop receives a modicum of seed and pours it, by means of a long narrow beak, into the bag which has come immediately beneath it. The bag filled, it travels

[a] W. Atlee Burpee & Co., Philadelphia, Selection in Seed Growing, etc., p. 97.

on till it reaches a slot into which it drops, receiving on its downward path a smear of mucilage on its flap and a squeeze to fasten it. It then drops into a receiver, where it is immediately followed by other bags which have been filled, gummed, and dropped in an endless stream. By this contrivance one operative can fill and gum 20,000 packages of seeds a day. From 125 to 150 hands are employed in handling of seeds in that house, having no agents at all; all their trade is done by mail and express. More than 4,000 seed orders have been filled in a single day, and the enormous number of 6,400 pieces of mail have been delivered at the store in one day, exclusive of newspapers and circulars.

As Mr. Henri de Vilmorin writes me, there are perhaps half a dozen houses in the United States which have such automatic package fillers and closers. There is also one, at least for trial, at the Department of Agriculture in Washington. It is not to be had in Europe, as the inventor seems to think that the selling in Europe might cover the high costs of the patents in all the European countries. Messrs. Vilmorin, Andrieux & Cie., Paris, have several apparatus which also make the filling of packages very easy and quick, and it seems not necessary for them to use the American machine, which costs $1,200 to $1,600. It is the high price of labor in the United States which makes such a machine profitable there.

A very ingenious mode for facilitating ordering and distribution has been invented by Vilmorin, Andrieux & Cie., Paris. They have running numbers in their price list which give not only the name of the seed, but also the quantity. So the customer has only to write a number, and he gets the seed in the quantity he wishes. Some seedsmen in the United States, especially D. M. Ferry, of Detroit, and in England, Sutton & Sons, of Reading, etc., mostly do a box business; that is to say, they deposit at their correspondents, grocers, druggists, general storekeepers, etc., boxes with seeds for a small or large garden; also single packages, which the depositary sells at a good profit, and returns the unsold seed at the end of the year.

EDUCTIAONAL MOMENTS.

Seed growing has not only a practical but also an educational side. In no business, perhaps, are there so many articles as in a seed business, and, therefore, the persons employed there are educated involuntarily to the greatest order. They are also induced to train their eyes to distinguish the minute differences of many seeds. The best school is the trial ground, and Mr. C. L. Allen is right when he says that the well-ordered trial is the curriculum for any young man who wishes to become familiar with every department of horticulture. Those who have studied on the trial ground the plant, its habits and

requirements, will make a good staff for a seed business, and be capable to fill the highest position.[a]

To this self-education by the business there comes another education done by the seedsman—that of the public. It can be said that in no other branch of commercial life is so much done for the instruction of the public as in the seed branch. Are all the hundreds of thousands of catalogues which go out from the seedsman and all their other papers, printed in vain? It is true it is a commercial interest which obliges the grower to send out catalogues; it is a commercial interest which induces him to adorn them from year to year with beautifully colored plates, so that they sometimes represent true artistic works, but at the same time these catalogues educate the public. They teach how to grow the garden seeds in a right manner; they stimulate to try the best new varieties, and they promote in a high manner horticulture in the most distant territory. Deviating from the general European custom, several great seed establishments in America have their own compositors for catalogues, addresses, names on seed, capsules, circulars, etc.

PROGRESS.

A comparison between now and thirty years ago shows a great difference, especially in the seed trade of North America. It was the time when the first shipments of American clover seed, Kentucky blue grass, and timothy grass to Europe began. How enormous are the quantities sent out now; but we have to speak of horticultural seeds, and there we can say:

(1) In horticultural seeds exportation has also increased in a great proportion.

(2) The principle of division of labor is brought to an issue, not only between the growers of one country, but also between the different countries of the world.

(3) The number of seedsmen has increased, also, in the United States and Canada rapidly, in the Old World more slowly, and competition is great both here and there.

(4) But more, perhaps, has increased proportionally the extension of the old, long-established houses. It is a pleasure to look upon the development of these world-renowned firms, which stand like rocks in the fluctuation of time—rocks which send down fecundating sources to all regions of the earth.

(5) The greatest progress lies in the raising of new and better, often earlier, varieties, both in vegetables and in flowers. No article can demonstrate, perhaps, that better than the tomato, which, after C. C. Morse,[b] was entirely unknown in the United States to the generation

[a] C. L. Allen, "Modern methods of the seed trade," Florist Exchange, New York, September 16, 1893, reprinted in Selection in Seed Growing, p. 68.

[b] "American seed growing," in Selection in Seed Growing, p. 35.

that preceded us, although it is a native of South America; now it takes its position with the potato and the cabbage as a common article of food, for by selection and hybridization it has been changed from the little pear-shaped "love apple" to a magnificent fruit. No vegetable fruit, perhaps, has given such varieties of forms, sizes, and colors as the tomato, both in the United States and in the southern parts of Europe. One of the greatest specialists in tomatoes—Mr. Livingston, father of the house of A. W. Livingston's Son, Columbus, Ohio—told me that they sell 6½ tons per annum of tomato seed—2½ tons from their own grounds, the rest grown by their contractors. With this seed 200,000 acres of land could be sown. His Buckeye State tomato, shown at the Horticultural Congress at Chicago, was 37 centimeters in circumference. Like Mr. Livingston, many other growers are working in the perfection of the tomato and thousands in the perfection of other vegetables and flowers. How wonderful is the progress in asters, mostly made in Germany and France; how delightful the colors of sweet pease, which owe their greatest perfection to England and America; how astonishing the varieties of the carnation, in which all horticultural places have nearly the same merit; and so hundreds of other articles might be cited.

(6) But the perfection of vegetables and flowers has often one reverse; the more a plant removes from the original wild form the less it will give seeds, and so we find that in the high-bred varieties of our time seeds become rarer and rarer, as the cucumber and tomato show best. Therefore, the seed of good varieties can not be cheap; that the customers should consider. Yet competition forces the seed grower to produce even good seeds as cheaply as possible, and that he can only do when he becomes a specialist.

(7) Once more must be mentioned the great progress in the horticultural, especially in the seed catalogues, as well as in the illustrations of horticultural articles, and in the same way the progress in the horticultural newspapers. They all act in the promotion of horticulture in a formerly unknown way, and each progress made in one country is soon the common property of the whole world.

SPECIAL DESCRIPTION OF GROUP 24.

In view of the great importance of the seed-growing and the seed trade the World's Fair Commission had classified group 24, seeds, seed raising, testing, and distribution, in six classes:

CLASS 179. *Display of vegetable and flower seeds grown in different latitudes.*—This class had no entry at all, and if the true meaning of the programme should have been fulfilled—that the same sample be sent to different latitudes and cultivated there several years—it would have afforded many years of preparation.

CLASS 180. *General display of flower and vegetable seeds by seed houses or growers.*—This was the only class which had found earnest competitors, and shall be reported on in the following. All the other classes, except class 184, remained more or less a vain desire; in the best case were intermixed in class 180. The other classes were:

CLASS 181. *Methods of growing, harvesting, and preparing flower, vegetable, tree, and shrub seeds.*—Although it is a difficult matter to demonstrate such methods, it could have been of the greatest interest to see models, or at least photographs. Unfortunately very few in this respect were shown. The first edition of the catalogue mentioned the Smith Pneumatic Transfer.

CLASS 182. *Seed warehouse, methods of burnishing and packing for the retail trade, work of packing, etc., in operation.*—To this class may be reckoned the model of Peter Henderson & Co., New York, showing their great warehouse, 35 and 37 Cortlandt street, from the outside, with all details, moving figures going in and out, etc., but this was more for sight-seers than for the men of profession. How interesting would it have been for the public as for the practitien to see, for instance, the automatic package filler and closer worked by steam, of W. Atlee Burpee & Co., Philadelphia, Pa.

CLASS 183. *Methods of testing vitality of seeds as practiced by different seed houses.*—It would have been very easy to show these methods but perhaps it looked too simple and nobody thought it necessary. The truth is that in America the seedsmen nearly all use the old method of testing their seeds in pots or in benches in the greenhouses, whereas in Europe, besides pots, also special testing apparatus are used most frequently. Certainly such seed testers also will be used by the agricultural stations in the United States, but in the whole exhibition I noticed only one improved tester, the Geneva seed tester, improved form, by E. L. Copp, Madison, Wis., in the collection of the agricultural stations in the Government building. It consists of a piece of asbestus through which iron pins have been drawn, the asbestus piece being folded many times and hanging with the folds in a chest filled with water. The new feature in this tester is the use of asbestus instead of flannel, or blotting paper. The asbestus may be made red-hot to kill all mold germs, etc. In Germany one prefers blotting paper, which can easily be renewed; only for beet grains, etc., one mostly takes wet sand.

CLASS 184. *Tree and shrub seeds, and seeds used for condiments and medicines.*—A part of these seeds were exhibited in the forestry department, another in the agricultural department; in the horticultural department some were attached to the general seed displays and only a few pure collections of tree and shrub seeds were to be seen. (See further on Germany.)

UNITED STATES.

Coming back to the chief class 180, general display of flower and vegetable seeds by seed houses or growers, we have to regret also here that the number of exhibitions was not greater. D. M. Ferry & Co., of Detroit, Mich., the largest seed house in the United States; Atlee Burpee & Co., Philadelphia, of nearly the same importance, and the Steele Briggs Marcon Company, Limited, Toronto, the largest seed house in Canada, had not exhibited. The catalogue names from the United States only 7, but among these 7 were some of the greatest houses of the Union—Henry A. Dreer, Philadelphia; Peter Henderson & Co., New York; Pitcher & Mandu, Shorthills, N. J., and Y. C. Vaughan, Chicago. Peter Henderson & Co. also had exhibited in a grand style in the agricultural building, where still another great house, Albert Dickinson & Co., Chicago, and further Vilmorin, Andrieux & Cie., from Paris, had exposed their great collections.

There were still some other exhibitions of which we will speak first. H. W. Buckbee, Rockford seed farms, Illinois, had arranged his collection in a very pretty manner; all seeds were in pretty, large, green or red silk bags on a terrace, with a large mirror behind and a brass bar before, a book with the request, "Please write your address, to get a catalogue" lying out. This latter is a very common custom in America, which should be more frequently accepted in Germany. H. W. Buckbee especially grows vegetable seeds, onions being the principal, but also cabbage and sugar corn. Of course it would not have well been possible to exhibit flower seeds in such quantities, but the public did not miss them, and the great quantities of vegetables in the pretty bags attracted it very much.

The Michigan Seed Company, South Haven, Mich., exhibited in a smaller style about 115 flower and vegetable seeds. Their specialties are beans and radishes.

G. Barteldes & Co., Lawrence, Kans., had exhibited vegetable and grass seeds in large bags. Some of the grass seeds were not quite clean; the whole samples were true samples of the commerce, not extra made up for the Exposition.

Henry A. Dreer, Philadelphia, has one of the greatest horticultural businesses in the East. Not only seeds, but also a great many plants, especially palms, azaleas, carnations, ferns, etc., are grown in the establishment out of town at Riverton, beyond the Delaware, in New Jersey, comprising 130 acres with forty-four greenhouses,* while in the store, 714 Chestnut street, Philadelphia, seeds, bulbs, and also implements are sold. In Chicago Mr. Dreer made a fine display, especially of vegetable seeds, etc., and his collection of implements was one of the

* We saw there, under the kind direction of Mr. Thilow, six palm houses together, each 105 by 25 feet; 50,000 seedlings of Livistonia australis (*Lutania borbonica*); 2,000 asparagus plumosus vanus; 400,000 ferns, etc.

best of all. The business was established in 1838. In 1883 Mr. Dreer had a quarter of an acre of sweet pease, employed 35 persons, and shipped 15,000 packages; in 1893 he had 6 acres of sweet pease, employed 70 persons, and shipped 70,000 packages. The firm is now incorporated, and its president is Mr. William F. Dreer, the son of the founder.*

Peter Henderson & Co., New York, the greatest house of that city, the eldest of all North America, and well renowned in the whole world, had brought most sacrifices of all American seedsmen. As has already been mentioned, they had not only exhibited in the horticultural, but also in the agricultural building, and in both places in a highly attractive manner for the public. For our purpose it may suffice to describe the exhibition in the horticultural building. In the middle of a large pavilion stood the model of their warehouse, 35 Cortland street, New York; around were placed large vessels with vegetable and grass seeds, and the pretty little paper bags with flower seeds, the whole decorated by exact models of the best vegetables, etc., by colored plates, figures, etc. Also several books were exposed, for Mr. Henderson is one of the rare gardeners who not only do practical work, but who understand how to spread their knowledge by popular publications. So we found: Henderson's Gardening for Pleasure, second edition, 1892; Henderson's Handbook of Plants, second edition; Practical Floriculture, fourth edition, out of which we learn that in New York there are 500 florists with $6,000,000 capital—in several businesses more than $100,000; Henderson's Garden and Farm Topics, 1884; How the Farm Pays, by Henderson and William Crozier, 1884; at last, Henderson's Gardening for Profit, 1891, in which he says that a gardener must have at least $1,500 to $2,000 capital, and then not more than 2 acres, either bought or ten years on lease. It is highly interesting to see Henderson's numerous greenhouses in Jersey City Heights, N. J., where there are cultivated roses in assortments (here mostly in pots what elsewhere is rare in America), chrysanthemums, palms, vines, etc. They also have large trial grounds in Hackensack. The business of Peter Henderson & Co. was founded by Peter Henderson in 1847 and incorporated in 1890, Alfred Henderson being president; Charles Henderson, vice-president and treasurer; Robert Liddell, secretary. In 1883 they had about 100 persons; in 1893, 200. How great the correspondence is follows by the single fact that in 1894 in one day of the chief season they received 4,000 letters and postal communications. Their specialties in garden seeds are cabbage, celery, cauliflower, pease, and beans. One variety of extra early pease alone takes 1,000 to 1,200 acres to produce enough for their trade annually during the past three years.

* The City of Philadelphia, 1894, second edition, p. 216.

The Michigan Seed Company, South Haven, Mich., exhibited in a smaller style about 115 flower and 150 vegetable seeds. Their specialties beans and radishes.

Pitcher & Manda, Shorthills, N. J., is that grand horticultural establishment to which the World's Fair Commission is much indebted, for they have contributed in store plants more than any other house, and without their huge tree ferns, their orchids, and other plants, renewed the whole summer, the horticultural building would have lacked some of its most attractive features. It is a delight to see their vast establishment in Shorthills. Nowhere in America can one see such a variety of plants and flowers, indoors and outdoors; even nursery articles are to be found there. But we have to do here only with the seeds they exhibited, and this collection consisted of about 2,000 flower seeds, etc., in small paper bags as they are in use now in nearly all businesses, each bearing a colored figure of the flower which will come from the seed.

J. C. Vaughan, Chicago, is one of the greatest firms in the Central States, having office and warehouse at 146 and 148 Washington street; retail store at 88 State street; greenhouses, plant, and bulb grounds at Western Springs, Ill., near Chicago, and finally a branch establishment at 26 Barclay street, New York, where all European shipments are received. Mr. Vaughan was the horticulturist who saved the honor of Chicago itself in the floricultural department, for although there are so many florists in that city, most of them did not participate at the Exposition. Mr. Vaughan showed especially cannas in the choicest varieties, many of them not yet in commerce, gained by the celebrated raiser, Mr. Crozy, at Lyon. But Mr. Vaughan also made a grand display in seeds and his pavilion was a worthy counterpart to that of Messrs. Henderson & Co., New York. Seeds of all kinds, vegetable and flower seeds, grass seeds, etc., in vessels of different forms, large and small ones filled the middle and the sides, and a good decoration was produced by living flowers. Mr. Vaughan had the great advantage to be nearest to the Fair, and he had in the person of a young lady a representative all the time, which would have been too expensive for the other houses.

The Albert Dickinson Company, Chicago, had not exhibited in the horticultural hall, but in a fine manner in the agricultural building. They handle chiefly field seeds—clovers, lucerne, timothy, and the natural grasses of that country; also linseed. Of the latter they sold, during the past five years, probably 1,500,000 bushels per year. The dealer of field seeds, especially in America, can not do like the dealer in garden seeds; he can not have seeds grown, except in special instances, exclusively for him. The territory and the quantities handled being so extremely large, it would be impossible to contract growing. So, also, the Albert Dickinson Company buys seeds in the

open market or from country shippers. Most of the seeds they sell are raised in that country, the same as grain crops. The quantities of seed handled in the Chicago market exceed any market in the world, especially in timothy seed. The Albert Dickinson Company also prepared tables of equivalent quotations on clovers and grass seeds as reduced from standard bushel to cental system and cental system to bushel. They commend the change to the cental system, but they should not have stopped half way; they should have promoted the use of 100 kilograms instead of 100 pounds English. God bless the day when England and the United States shall adopt the metric system in weights and measures.

FRANCE.

Although France had exhibited no seeds in the horticultural building, it would be unjust not to name it here, for its greatest house, Vilmorin, Andrieux & Cie., Paris, had exhibited in a grand style in the agricultural building, especially agricultural seeds, cereals, self-grown hybrids of cereals, sugar beets with plastic demonstration of their composition, cast models of vegetables, etc., paintings of flowers, etc. Before the beginning of the Exposition, Messrs. Vilmorin, Andrieux & Cie., on request of Mr. Samuels, chief of the horticultural department, had supplied many of their best flower seeds, which Mr. Thorpe, the chief of the floricultural department, cultivated like those of other countries, and they were highly rewarded when the flowers came in bloom. They published, on the occasion of the Chicago World's Fair, a little pamphlet of only 12 pages which contains valuable statistical data. From this we extract the following:

History.—No precise data are extant on the exact time when the house of Vilmorin, Andrieux & Cie. was founded. It existed, however, already in 1745, on the Quai de la Mégisserie, and belonged to Pierre Andrieux, seedsman and botanist to the King, Louis XV. In 1774 Philippe Victoire Lévêque de Vilmorin married the daughter of Pierre Andrieux, and after the death of the latter in 1781 the firm took the name of Vilmorin, Andrieux & Cie. The son of Philippe Victoire (died 1804), Pierre André (1776–1862), was the first one to start the comparative field experiments with cereals, grasses, and forage plants. His friendly connections with Michaux, the celebrated North American traveler, offered him many opportunities for introducing American trees, and his forest tree plantation and rich collection of American oaks at Les Bannes, Département du Loiret, were acquired after his death, in 1862, by the French Government, to be used as a national forestry school. In 1845 he retired from business, and left the house to his eldest son, Louis Lévêque de Vilmorin, who made the systematic study of heredity in plants one of his great aims, and created the improved race of sugar beet called "Vilmorin," the blood

of which is in most sugar-beet strains introduced into America. He died in 1860. His widow, assisted by Messrs. J. M. Mies and J. Posth, conducted the house, and now her two sons, both worthy of their great ancestors, Henri Louis de Vilmorin and Maurice Louis de Vilmorin, together with Mr. Albert Bricka, who was for twenty years the chief of the growing department, and Mr. Th. Delacour, who for many years conducted the correspondence, are the four principals of the world-renowned house, Vilmorin, Andrieux & Cie.

Progress.—The progress of the house is well shown by diagrams. We can only give the end numbers:

Number of the staff, 1855, 42; 1893, 452 clerks; number of letters and postal communications, 1847, 2,410 letters; 1855, 15,472; 1893, 265,319 letters. Acreage under seed crops, 1855, 1,677; 1893, 11,152 acres. Packages yearly shipped to the United States alone, 1883, 2,652; 1892, 12,248. The three main divisions are the growing, distributing, and publishing departments. The seed gardens and farms, which include also the trial grounds with 20,000 different plats of land, are located at Rue de Reuilly, Paris, at Vierrières le Buisson (Seine et Oise), and at Antibes (Alpes Maritimes) on the Riviera. The chief work, all systematic classification of wheats and other cereals, potatoes, grasses, the hybridizing of wheat, etc., by Messrs. Louis and Henri de Vilmorin, were accomplished at Vierrières, where also is a chemical laboratory for testing sugar beets.

Distributing department.—All the offices are located at 4 Quai de la Mégisserie, Paris, but the warehouses are all at Rue de Reuilly. Here the inland retail department especially has been pronounced by all who have seen it to be the most practical in existence. The labor of that department is simplified by the system of enumeration, permitting the customers to make out their orders by merely writing on the order sheets the number which is annexed to each article. For instance, No. 2183 of the catalogue means 125 grams beet root, red, from Covent Garden; No. 2184 of the catalogue means 60 grams beet root, red, from Covent Garden; No. 2185 of the catalogue means 30 grams, etc., beet root, red, from Covent Garden. This also renders the execution of the orders very easy to persons without special training—women, for instance. A system of movable drawers allows of a novelty being put in between two numbers without changing the whole arrangement.

Publishing department.—As there are published nearly a score of catalogues and price lists every year, the publishing department has much to do. The main price list is sent yearly to more than 100,000 customers. Nearly all catalogues and lists are nicely illustrated, and the introduction of 10,000 cuts is already an old feature of the house. In the later years also good chromos for seed papers and for address cards have been published in great numbers. A most valuable pub-

lication is the Album Vilmorin, containing large lithographs painted by hand of vegetables and flowers. The chief publications are Les Fleurs de Pleine Terre, fourth edition, 1893; Les Plantes Potagères; Les Meilleurs Blés; Les Plantes de Grande Culture, etc. To the publishing department must be referred as well the production of casts of the useful vegetables and farm roots, which are very valuable for museums, horticultural schools, seed growers, etc. The other seed firms of France are mostly of more recent date. The most important are in Paris, at Angers, Lyon, and Nimes. For flower seed also Nice and the whole Riviera are great centers, for instance, for Primula sinensis, carnations, cineriaras, stocks, dahlias, melons, subtropical plants, etc.

GREAT BRITAIN AND IRELAND.

Although one should think that the moist climate of the British islands would not be suitable for seed growing, yet there are some articles which there gain their greatest perfection. In general these are more agricultural seeds and vegetable seeds, but also some flower seeds (partly grown in houses—for instance, Primula chinonsis, byclemson, etc., as in Germany and other countries). Beginning with the north there must be cited the ancient house, Peter Lawson, Edinburgh, the founder of which was the first seedsman in Great Britain, who, like Louis Lévêque de Vilmorin in France, began raising of cereals, especially wheat, in a scientific manner, being preceded by the Rev. Patrick Shirreff, who showed the way of gaining new varieties by selection and hybridizing. In the south it was the world-renowned Colonel Hallett who first began a true pedigree breeding of wheat and oats. What Peter Lawson did once, James Carter & Co., London, do now. They have gained several good varieties of cereals by a still more exact crossing. They also produced new potatoes and carried on tobacco growing in a scientific manner. But we have not to speak here of agricultural seeds. Suffice it to call in mind the many varieties of wheat, oats, barley, turnips, etc., which Great Britain has offered to the whole world. An article both agricultural and horticultural is grass seed, and it is well known how wonderfully the English rye grass seed (*Solium perenne*) is grown in Scotland, just as timothy in Ohio, bluegrass in Kentucky, etc., *Festuca ovina* in Germany, *Avena elatior* in France. As to vegetable seeds England can claim to have been the first country in which they have been grown scientifically. Thomas Andrew Knight, 1759–1838, president of the Royal Horticultural Society of London, was the first who hybridized peas already in the beginning of this century, and Knight's Marrow is still now a well-known pea. No country perhaps has produced so many varieties of peas as Great Britain, and the stranger only regrets that all these fine varieties are not cooked in England in such a delicate manner as in France

and Germany. The cooking of vegetables in general might be greatly improved in Great Britain as well as in the United States; it is mostly the sauce or the butter which is failing.

In England the two greatest firms are Messrs. James Carter & Co., 237 and 238 High Holborn, London, and Messrs. Sutton & Sons in Reading,* but we might still name many others. James Carter & Co. celebrated their fiftieth jubilee in 1887.* There had been before 1837 a seed, or chiefly a florist's, business by Mr. James Carter in Drury Lane, but in that year the firm of Carter & Co. removed to Holborn. Strange to say, James Carter, before becoming a seedsman, had resided in Germany, teaching music, botany, and English. Certainly his botanical and literary knowledge were of the greatest aid for him afterwards. His catalogue of 1836, from 5 Drury Lane, shows already his scientific knowledge. It is headed by an elaborate explanation of the Linnean system. The plants named are arranged alphabetically, but a series of columns stands ready to indicate the class and order to which each belongs, its hardy or half hardy character, its height, and time of flowering, color, price, etc.; also the names are properly accented, to direct pronunciation. He rebuilt the tiny shop of High Holborn in 1856, and after his death the agricultural side of the business grew rapidly, so that J. Carter & Co. are now known through the whole world, having resident agents in Paris and New York. They receive often 700 to 900 letters per day. The weight dispatched amounts in some of the spring months to 40 to 60 tons per day—one-half for foreign and trade destination, the other for home customers. They have a botanical assistant for testing the grains, especially examining clover seed for dodder.

The nurseries and trial grounds of J. Carter & Co. are situated near Forest Hill, and comprise some 20 acres, besides long ranges of glass houses where primulas, cinerarias, calceolarias, petunias, mimulus, balsams, etc., are grown in quantity for their seed. Of these seeds samples were sent to Chicago, and the plants grown from them were so splendid that J. Carter & Co. earned 9 awards. Actual stand exhibitors they were not. At Forest Hill also the wheat hybridizing takes place. The varieties of wheat "Fillmeasure," "Royal Prize,"

* At that occasion Messrs. James Carter & Co. published a pamphlet, from which the following notes are taken: "Messrs. Sutton & Sons, Reading, do the greatest business in England with the public directly, their commerce being chiefly a retail one. Not only flower and vegetable seeds, but also grass and agricultural seeds, beet roots, etc., are the specialties of this world-renowned firm. They also have published very valuable works on horticulture—for instance: The Art of Preparing Vegetables for the Table, Sutton's Amateur Guide in Horticulture, Sutton's Farmers' Yearbook and Graziers' Manual. The two most important are Permanent and Temporary Pastures, fourth edition, London, 1891, 184 pages, with 23 magnificent colored plates, the best figures we know of this kind, and The Culture of Vegetables and Flowers, fifth edition, London, 1892, 422 pages. Of the latter, 18,000 copies had been sold when the fifth edition appeared in 10,000 copies."

"Birdproof," etc., have been produced here. The chief place for cultivation of agricultural and also vegetable and flower seeds are the Essex Farms, nearly 1,200 acres, at Dedham and St. Osyth. Here stock seed from selected roots of turnips, swedes, mangels, kohlrabi; also of peas, radish, lettuce, etc., are grown for the supply of contracting growers. Of flower seeds there are at St. Osyth 10 acres, especially lobelias, candytufts, tropæolums, rhodanthe, mignonette, pansies, carnations, etc. At Dedham are 50 acres of flowers—chrysanthemum, carinatum, tropæolum, clarkia, insegripetala, mesembryanthemum.

GERMANY.

German seeds are known in the whole world and form a specialty of seeds, consisting chiefly of annual flower seeds and vegetable seeds, but in the last decenniums also a great many seeds of greenhouse plants are grown and shipped far abroad. The centers of the seed production in Germany are Erfurt, Quedlinburg, Aschersleben, Eisleben, Halberstadt, Grosstabarz, Mainz, Darmstadt, Bamberg, Aschaffenburg, Schweinfurt, Mittenberg, Nuremberg, Munich, Ulm, etc. Erfurt was already in the Middle Ages called "The Gardener of the Sacred Roman Empire," but at that time it produced especially vegetables. Seed growing did not begin before the middle of the last century, but already in 1788 Heinrich Platz gave in his catalogue a list of 1,355 flower seeds. To-day the culture is so extended that more than 500 hectare (about 1,250 acres) are alone covered with flowers for seed, and about 200,000 square meters (2,000,000 square feet) of glass surface serve for the cultivation of more tender flowers. Stocks are grown in about 1,000,000 pots, in each 7 to 9 plants; carnations, 100,000; wallflowers, 150,000. About 4,000 persons are occupied in this business, and above 2,000,000 catalogues are sent out into the whole world every year.

The greatest houses at Erfurt are Ernst Benary, Haage & Schmidt, T. C. Schmidt, N. L. Chrestensen, F. C. Heinemann, J. Doeppleb, Oscar Knopff & Co., H. Platz & Sohn, Ferd. Jühlke Nachfolger, H. Lorenz, etc. Together, there are 14 greater and 50 smaller houses. Nearly all the greater ones have contractors in the environs as well as in the south of Europe, in Algiers, in North America, and in the Tropics, who grow seeds for them. Often the houses furnish the seed themselves and carefully watch the harvest, especially in the environs. Most of these houses had sent seeds of pot plants on the request of Mr. Samuels, chief of the horticultural department at Chicago, in 1892. These were sown and well cared for by Mr. John Thorpe, chief of the floricultural department, and the flowers judged before the beginning of the Exposition. There were Primula chinensis, Cyclamen, Cineraria, Calceolaria, etc.; also the pansies were raised in 1892. Nearly

all were found worthy of an award; the Cineraria of Ernst Benary were considered the best of all as to number of specimens and color.

Although the production of seeds is the chief occupation in Erfurt, yet also plants, open-door, greenhouse, and stove plants are from year to year grown more. Messrs. Haage & Schmidt are well known through the whole world for their great variety of nearly all sorts of garden plants. They are for Germany, or even Europe, what Pitcher & Manda are for the United States. The establishment was founded in 1862; it has now an acreage of 250 acres, 2½ acres of glass, 200 persons, 20 acres of asters, 167 acres of summer flowers, 75,000 pots of stock, 18,000 of carnations, etc. For the greater part they deal in wholesale; therefore the number of letters is not so great as with those houses which especially deal in retail. The number of letters arrived in 1893 was, nevertheless, 35,000; in the chief season, 250 per day; packages shipped, 15,000, of which about 1,200 large ones to the United States. Haage & Schmidt gained two awards for Cyclamen.

N. L. Chrestensen, Erfurt, is another great house which exports besides seeds, especially dried flowers, cotillon articles, etc.; also cereals; he earned two awards for pansies, etc. Mr. Chrestensen was in the United States in 1892.

F. C. Heinemann's establishment at Erfurt was founded in 1847; acreage, inclusive of contract land, 312 acres; glass, 20,000 square feet; persons, about 100; letters received per annum, 70,000; number of packages shipped, 40,000; number of catalogues sent out, 135,000; prospects, 500,000 to 1,000,000. He cultivates about 6 acres of asters, 50,000 pots of stock, 4,000 pots of Gloxinias for seed, etc.

During the whole Exposition itself three Erfurt firms were represented: Oscar Knopff & Co., T. C. Schmidt, and E. Benary.

Oscar Knopff & Co. brought flower and vegetable seeds, well arranged on two round terraces of carved wood; the glass jars had the opening below so that the seeds could well be seen, but they were not well locked, so that sometimes in lifting the jars seeds feel out. The seeds were very good and earned an award, like those of T. C. Schmidt.

T. C. Schmidt, Erfurt, had chosen a white terrace, on which flower seeds were placed. On each jar was put an artificial flower showing what sort of plant the grain would produce. This was highly interesting for the public, although the seeds themselves sometimes could not well be seen for the flowers. T. C. Schmidt is well known in Germany and far abroad as "Flower Schmidt." It is an establishment which combines, like that of Mr. Chrestensen, many different departments, not only flowers and seeds, but also dried flowers, dried grasses, bouquets; also cereals, etc.; and deals especially with the public in retail. In this respect it is probably the largest house in Germany. The acreage in 1893 was, inclusive of contract land, 2,130 acres; glass

surface, 110,000 square feet; number of persons, according to the season, 450–800; number of letters received, 130,000; on days of the chief season, 1,200; number of packages shipped, 120,000; number of catalogues sent out, 250,000, and 1,000,000 of prospects, etc., in journals. The aster fields embrace 16 acres, stocks are grown in 40,000 pots, begonias in 10,000 pots. The firm T. C. Schmidt has special workshops for wire and willow baskets, for coloring flowers, for bookbinding, for making cotillon arrangements, etc., and the Exposition has added many customers to the thousands of old ones.

The largest and oldest seed house of Erfurt, Ernst Benary, founded 1843, conducted now by Friederick and John Benary, only deals in wholesale. It gave an idea of its world-renowned cultures and its organization by a large picture or tableau. The whole tableau, 28 feet long and 19 feet high, consisted of three parts, most artistically composed by Mr. John Benary, executed by Prof. Otto Hammel, Hannover, and his scholars, I. Stanzel and A. D. Cause. The middle part represented the large new warehouse with the offices, a magnificent building, looking like a municipal post building, with 4 floors, and 19 windows in face, and 2 large side wings, with electric lights, steam heating, elevators, etc., the left the flowers, the right the vegetables. All the publications of the house Ernst Benary were shown on this tableau, the celebrated Benary Album, the paper seed bags with the nicely painted flowers, etc. E. Benary grows about 100,000 pots of stock, 30,000 Primula chinensis, 20,000 petunia, etc., and has 90,000 square feet of glass. Mr. Benary has also published scientific works, popularly written; especially must be mentioned the propagating of plants by seed by H. Jaeger and Ernst Benary. E. Benary also possesses beautiful casts of his best vegetables, etc., similar to those of Vilmorin, Andrieux & Cie., of Paris.

J. Doeppleb, well renowned for his beautiful asters and pansies, had sent grains of the latter for cultivation and gained an award. Platz & Sohn gained even two awards for their pansies.

From the other centers: Quedlinburg, where seed growing on a large style was founded about 1840 by Martin Grashoff, four firms had sent seeds for being cultivated during the winter in the floricultural department—Gebrüder Dippe, Heinrich Mette, Martin Grashoff, Pape & Bergmann, and Luther Friedrich Roemer sent seeds of his new Humulus japonicus variegatus for the open air; Sattler & Bethge, dahlias.

In Quedlinburg the acreage for seed growing is still larger than in Erfurt, because there are grown many agricultural seeds too, especially sugar beet and cereal seed. The largest seed house of Germany—nay, probably of the whole world—is Gebrüder Dippe, at Quedlinburg. Dippe Brothers have 17,675 acres. That is 6,723 acres more than the celebrated house of Vilmorin, Andrieux & Cie., at Paris. They cultivate

2,250 acres cereal seeds, 1,500 acres of their world-renowned sugar-beet seed, 375 acres peas, 237 acres beans, 137 acres salade and onions, 37 acres cucumbers, 75 acres asters, 45 acres mignonette, etc.; further, of pot plants, 350,000 pots of stock, 36,000 wallflowers, 15,000 cineraria, 5,000 calceolaria, 50,000 Primula chinensis. They employ 230 gardeners, 30 apprentices, 1,600 male and female laborers. They have 2 steam plows, 240 horses, 220 oxen, and 5,000 to 6,000 wethers—the latter for getting more manure.

The greatest merit of Dippe Brothers is the amelioration of the sugar beet. Already since 1879 Kommerzienrath Carl Dippe, now one of the chiefs of the firm, occupied himself with the selection of the sugar-beet roots as to form, leaf, polarization, etc. Since 1884 he has combined the determination of sugar in the root, which now is the usual method with the ancient determination of sugar in the juice, and the factories have found that the beet roots of Dippe Brothers at equal polarization and equal quantitative product gives 0.9 per cent, nearly 1 per cent, more revenue than other varieties.

But there are still other large firms at Quedlinburg.

Heinrich Mette & Co., Quedlinburg, have 2,125 acres of land, besides 2,062 acres of contract land, 85 gardeners, and 550 laborers. Martin Grashoff, in the same town, cultivates 1,125 acres with 55 gardeners and 200 laborers. Sattler & Bethge Co., Limited, have 27 houses, 5,000 frames, altogether above 6 acres glazed surface, 60,000 Primula chinensis, 25,000 cyclamen, 20,000 begonia in pots and 50,000 in the open air, 25,000 gloxinia. They shipped in 1893 2,000,000 young Primula chinensis and 500,000 young cyclamen. Other well-renowned houses are Pape & Bergmann, Karl Sattler, August Temple, H. Wehrenpfennig, Gebhardt & Co., Louis Vieweg, etc.

Forestry seeds are a specialty of Grosstabarz, in the mountains of Thuringia, called Thüringer Wald, in the center of Germany. The two chief firms there, Helms Söhne and Boettcher & Voelker, had exhibited in Chicago. The house Helms Söhne was already established in 1788, by the grandfather of the present proprietor; it was the first house which paid attention to the important forestry seeds, and this had such good success that in western Germany, in Darmstadt, about ten years later, establishments for forestry seeds were also created. Afterwards, in the south of Germany also, the commerce with foresty and grass seeds began, and many hundreds of poor people now find a good means of livelihood by collecting cones and ripe seeds. The chief localities for forest seeds are now Grosstabarz, Darmstadt, Blankenburg at the Harz Mountains, Celle, Rathenow, Aschaffenburg, and Munich. Messrs. Helms Söhne have establishments for opening the cones (Klenganstalten) with heating by hot air, of the newest construction, and other machineries for cleaning the seed in the best way. They were on occasion of their centennial jubilee named furnishers of King of Prussia and of the Duke of Saxe-Coburg-Gotha.

In Chicago Helms Söhne had exhibited 480 tree and shrub seeds on desks, each species in pretty cases closed with glass. Such flat cases always give the most correct appearance of the seeds; vaulted jars cause that the grains look larger.

Boettcher & Voelker, also at Grosstabarz, did not exhibit so many forest seeds, but added also grass and clover seeds; all were inclosed in cylindrical glass jars, with a glass stopple below. They had about 500 glass jars. Both firms earned a well-deserved award.

On the gallery of the dome, M. C. Stoldt, a well-known horticulturist of Wandsbek-Marienthal, near Hamburg, had exhibited seeds of his self-grown varieties of cyclamen: Kaethchen Stoldt (white), Rosa of Marienthal (rose), bright dark red and white with common eye.

A specialty of Germany are the fine pansies, and although we have already mentioned several firms who exhibited pansies at Chicago, we must name two specialists: Mr. Carl Schwanecke of Oschersleben, province of Saxony, the nestor of the pansy growers, who earned two awards, and Mr. Heinrich Wrede, of Lüneburg, who even gained four awards for pansies, besides another for phlox.

The other countries of Europe had not exhibited grains in the horticultural hall; but we only have to mention Mr. Bredemeier, from Pallanza, Italy, who sent seeds of his Primula chinensis "Pallanzæ," with curled leaves.

HEATING APPLIANCES.

BY

Prof. R. HITCHCOCK.

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I believe that Dr. Emin, the famous African explorer, is responsible for the statement that a particular tribe of monkeys, found in the interior of Africa, is acquainted with at least one of the uses of fire. These monkeys provide themselves with torches of burning wood to light their way through the forests at night. If it is true, the use of fire may antedate by many centuries its earliest use by man, for even now there are said to be savages who have no knowledge of its application to the preparation of food.

It is not the writer's purpose to begin this report with a history of the early uses of fire, or even to trace the course of invention and improvement which has led up to the modern appliances for heating houses and cooking food. We may presume that primitive man, as soon as he experienced the genial warmth of fire, discovered a means to transport it to his dwelling and to preserve it there. At a later time the means to produce it were discovered, first by the rubbing of two sticks together, or by the fire drill so extensively used throughout the world; later, in a still dim antiquity, the use of the flint and tow was discovered, which continued among our own people until the days of our grandfathers, and is still found in other lands in daily use.

The campfire and the blazing signal fire or beacon typify the earliest uses of fire. But it could not have been long before the first step was made to conserve the heat and apply it to cooking in a different manner. The primitive oven, such as is used by the American Indian at the present day, is a hole dug in the ground into which hot stones are thrown and covered with leaves and earth. The modern stove is a marvel as compared with the early forms known half a century ago, but even in some of its best forms it is very far from being what it should be in this enlightened age. It is a most extravagant luxury. For heating our houses it falls far short of requirements, consuming and wasting an unconscionable amount of fuel, giving comparatively but little warmth, and even that unevenly distributed. For cooking one need only compare the hodfuls of coal used every day in the ordinary home kitchen with the few cents' worth of oil which Mr. Edward Atkinson has shown will do the same work. Or if it is contended

that the conditions under which Mr. Atkinson's results were obtained are not comparable with kitchen operations, then take the result given in this report of some rather rough-and-ready experiments with the Nevins range. Improvements in cooking stoves generally have not kept pace with the demands of the times for efficiency or for economy of fuel.

No doubt the luxurious manner of living, in this country, of persons in very ordinary walks of life has led to a disregard of improvements in kitchen apparatus, and it would seem to be a fact of experience that the devices of Mr. Atkinson, originally intended to improve the dietary of the laboring class and at the same time to enable them to live more economically, remain quite unappreciated by the persons who have most need of such benefits, and are as yet only used by those to whom the saving of money is but of little consequence.

With all the improvements in appliances for domestic use we are far behind less highly cultured peoples in the matter of the economical use of fuel. The waste in the common kitchen range would soon impoverish a Japanese household, wherein the family meal would be cooked with the wood which one of our servants uses merely to kindle a fire for breakfast.

A. AIR HEATERS; AIR, HOT-WATER, AND STEAM COMBINATION HEATERS.

The variety of air-heating furnaces is almost endless, but only a few were represented at the Exposition. These naturally represented the latest and most approved designs, but it is quite obvious that there is still a wide field for improvement in most of them for the more economical use of fuel. Without any disposition to speculate upon a subject which is well worthy of scientific investigation in a practical way, I would suggest that if we could eliminate the expression "radiating surface" as applied to heaters and substitute for it "heating surface," with the clear understanding that air is heated by actual contact with heated surfaces and not by radiation from such surfaces, the language would not only be more exact, but it would doubtless lead to the abandonment of some forms of construction which are obviously planned to heat a large volume of air by radiation. Suppose we assume that our furnace is a simple drum, which furnishes the entire heating surface for the air. We can surround that drum with a casing to confine the air and to direct it upward. The question arises, How much air space should be given between the drum and the casing? Shall it be 6 inches, or a foot, or 2 feet? So far as the absolute amount of heat radiated by the drum and absorbed by the casing is concerned, to which the air is practically transparent, and which therefore does not warm the air in its passage, there will be no difference. It is only the moving air which comes in direct contact with the drum, and that which is also warmed by contact with the

inside of the casing, that serves to heat the house. Practically, therefore, it becomes a question of either heating a small volume of air very hot or a larger volume to a lower temperature. The absolute amount of heat imparted to the air being dependent, in a great degree, upon the rapidity of the current in contact with the hot surfaces, this becomes an important consideration, for the more rapid the current the more effectually the surface of the heater is cooled—in other words, the more heat is taken from the fire. The greatest efficiency is attained when the heating surfaces are most rapidly cooled by the moving air. A large body of air moving slowly in a given space, over a hot surface, will not absorb heat so rapidly as a smaller volume moving more rapidly. Even if it be assumed that the larger volume will carry away the same quantity of heat as the smaller, it can only do so at the expense of a greater consumption of fuel, for the reason that in order to heat the larger body of air it will be necessary to heat that portion of it which comes in contact with the heating surface to a higher degree, and to do this requires a hotter surface. This is purely a practical view of the matter. Theoretically, the amount of heat and the temperature should be the same for comparable volumes of air, but practically it is not so, because uniformity of heating the entire volumes of air can not be attained, and in maintaining a higher temperature of the drum more fuel goes to waste up the chimney.

The most efficient furnace is the one which exposes the greatest amount of heating surface to a constantly moving and rapid current of air. The function of the heating surface is to absorb the heat on the one side and to give it out to the air by contact on the other. Consequently we must heat it as quickly as possible and carry away that heat as rapidly as it is imparted. It is not possible to take up all the heat from a simple drum, because much of the heat of the fire passes away in the escaping products of combustion without coming in contact with the metal. Therefore it is customary to direct the hot gases into smaller flues, preferably directed downward, before they are allowed to escape. The favorite method among many furnace makers now is to join these down flues to a horizontal flue, running around the furnace to the back, where an up flue carries the gases into the chimney. Thus we find the "horseshoe" construction adopted, in its various forms, by several makers.

Before leaving this subject one may be allowed to suggest that there is still great opportunity for improvement in the best of furnaces of this type. Much heat escapes up the chimney which might be utilized, and although makers of furnaces, stoves, ranges, etc., claim for their particular construction perfect combustion, most of them have failed to show evidence thereof. The conditions requisite for the heating of air are the same as those attending the heating of metal by the hot

gases in the flues. Contact is necessary in both cases, the only difference being that the hot gases should move slowly. It has been known for many years that the effective heating surface can be increased very much by the addition of metal projections from the surface. This was practically applied to heaters long ago, the Chubbuck cast-iron fire pot being a good example, and at the Exposition it was well carried out on the Superior furnace, as well as on the excellent Jackson fireplace heater. In the transportation building the same device is shown, applied to the interior of boiler flues, to more effectually absorb the heat, and, it is claimed, with great advantage in practice. The more general application of this device to heating furnaces would be of undoubted benefit.

There is one other point in connection with hot-air furnaces that must be touched upon here. We hear much about "burning the air" by having the heating surfaces too hot. At the present day, it is only the cast-iron furnaces of inferior construction that become hot enough to "burn" the air. As a rule, cast-iron furnaces are to be condemned for house use. While we may tolerate the use of cast iron in the form of heavy fire pots, such as are used in some of the best furnaces, further than this we can not go. There is no doubt that there are many cast-iron furnaces in use, and that they are effective heaters is not to be questioned, at least when they are new; but cast metal is very liable to crack, and the numerous joints in the ordinary construction are liable to permit gases to escape.

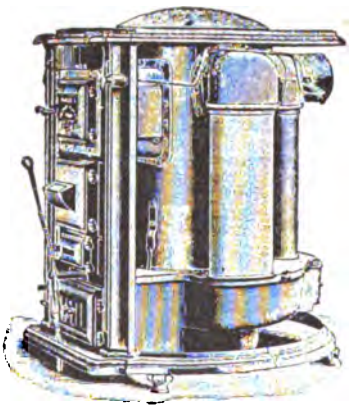


FIG. A—Boston heater, lined pot.

There are three forms of warm-air furnaces, which can be best described together, because of their close resemblance in external form. These are the Magee Boston heater, the Smith & Anthony Company's Hub heater, and the Ridgeway open fire-pot heater. They will be described in the order named.

The Boston heater, manufactured by the Magee Furnace Company, of Boston, is represented in Figure A. It is made either with a continuous plate-iron cauldron or drum, the lower part of which is lined with fire brick to form the fire pot, while the dome is of heavier metal to withstand the heat, or with a fire pot of cast iron. The large ash pit is cast, and the distinctive feature of the furnace is the combination of the ash pit and the base flue, or "horseshoe" flue, which are cast in one piece. The advantage claimed for this construction, as compared with the detached flue to be described hereafter (see figs. C

and E), are, that it is stronger and overcomes the difficulty of keeping the joints of the down flues tight, a serious leakage of gas resulting in other forms, due to alternate expansion and contraction. There is also the further claim that the air which is to be heated is brought into closer contact with the heating surface of the furnace than is possible with a detached flue.

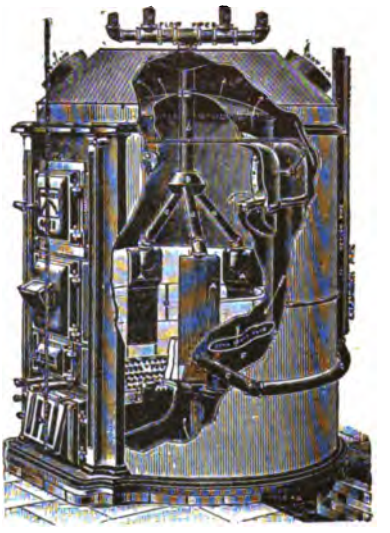


FIG. B.

There is a difference in practice regarding the relative sectional areas of the vertical flues. In the Magee furnace the sectional area of the back flue is just one half of the combined sectional area of the two down flues. In the other furnaces of this type on exhibition the back flues are relatively much larger. It is perhaps true that the smaller flue is to be preferred, for the reason that if the smaller flue is sufficient to do the work any increase in size would tend to draw the hot gases quicker into the chimney, and loss of heat would result.

The Magee combination Boston heater for warm-air and hot-water heating is represented in figure B. It is the Boston heater with the addition of a most excellent arrangement of water logs or sections, clearly shown in the figure, which can be introduced into the heater at any time, either singly or in sets of three, four, or more, in the manner represented. The return water is received by a pipe which passes around the furnace, on the outside of the casing. The hot water passes out at the top of the sections and is carried into a delivery disc, in which it is also exposed to strong heat, and then passes into circulation through the radiators. There is much in this arrangement to be commended. The simple means of changing from an air-heating furnace to a combination heater by merely introducing the water sections in place of some of the fire brick

FIG. C.—Hub heater furnace; boiler plate furnace with brick-lined firepot.

lining of the furnace, is admirable, and the direct, upward flow of the water through the hottest part of the furnace, gives a rapid circulation. The sections do not occupy much space within the furnace and interfere but little with the utilization of the heat for warming the air.

The Hub heater furnace, manufactured by the Smith & Anthony Company of Boston, is represented in figure C. This furnace is the successor of the Blanchard furnace, introduced by the same firm in 1871, which was the first furnace made in New England with a detached or horseshoe flue. The makers claim to be the pioneers in the introduction of this form of heater. It will be observed that the horseshoe

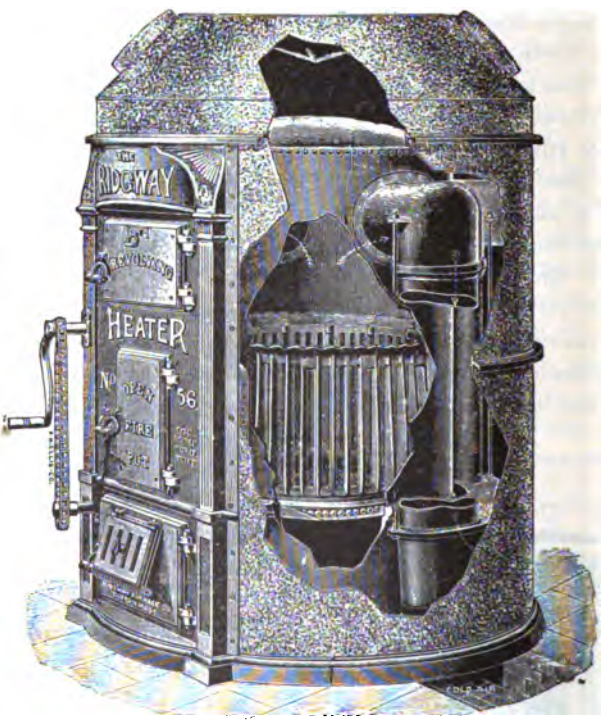


FIG. E.

flue rests upon the floor of the furnace and is quite detached from the ash pit, leaving a space for the circulation of air between the inside of the flue and the ash pit, as well as between the outside of the flue and the casing. The damper connection in this furnace is the result of considerable study.

The Ridgeway revolving open fire-pot heater, of the Ridgeway Furnace Company, of Boston, which is represented in figure E. This furnace belongs to the same plan of construction as the two already described, being, in fact, almost identical in external form with the Hub heater furnace. It is characterized by the peculiar form of the

fire pot, which is made up of vertical sections fitted together to form a circular pot, which revolves on ball bearings. The structure of the fire pot is clearly shown in figure F, and the manner of operating it in the furnace, with a crank and chain pulley, as well as the ball bearings, as shown in the large cut. The advantages claimed for this fire pot are, that there is no brick lining to obstruct the direct radiation of heat laterally from the fire, the ease with which the fire can be kept clean and its condition known at a glance, the excellence of the combustion, due to the passing of the air from below outward between the bars, especially when fresh fuel is added. It would seem that the claim of increased radiation from the fire is well founded, and from this we may infer that the heating capacity of the furnace is increased thereby. There is a direct draft damper which works automatically when the fuel door is open; but while the arrangement of this is ingenious and convenient, the damper-bar passes through the combustion chamber. The manner of attaching the return base flue is shown in the figure. It is suspended from the elbow above, and rises and falls with the expansion and contraction of the drum.

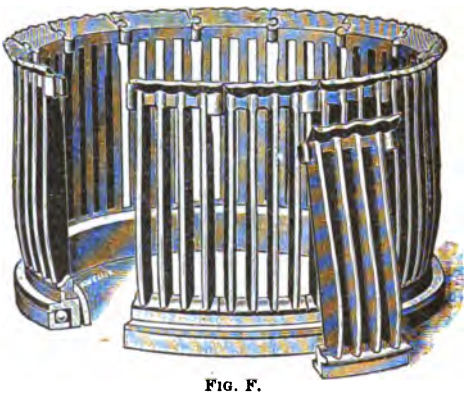


FIG. F.

The construction of furnaces of this type undoubtedly requires that the greatest attention should be given to the joints. The leading makers, such as are represented at the Exposition, have not failed to recognize this fact. It is obvious that the expansion and contraction of the drum must be considerable, and that the down flues will consequently work more or less up and down in their joints. Three different methods to avoid leakage from this cause have been adopted by the three makers represented. First, we have the Magee furnace with the combined flue and ash pit. In this the weight of the down flues is borne by the solid casing and the lower joint may be made quite tight without difficulty. There remains only the upper joint which requires special care.

Next we come to the Hub heater, in which the detached radiator is supported independently from the floor, and in respect of the flue junctions does not obviously differ from the Magee, except that in this form rigidity is not aimed at, and allowance is made for some movement by the use of a very deep joint.

Finally, we have the Ridgeway furnace, in which the detached base flue is suspended by rods from the elbow on the drum in such a man-

ner that as the drum lengthens or contracts the base flue is carried up and down with it.

Great advantages are claimed by each maker for his particular form of construction.

It will not be necessary to describe in detail the construction of the excellent warm-air furnace known as the "Economy steel-plate furnace," manufactured by the J. F. Pease Furnace Company, of Syracuse, N. Y. The return flue is connected with the steel drum by short, curved elbows, so that there is no down flue, but the horseshoe

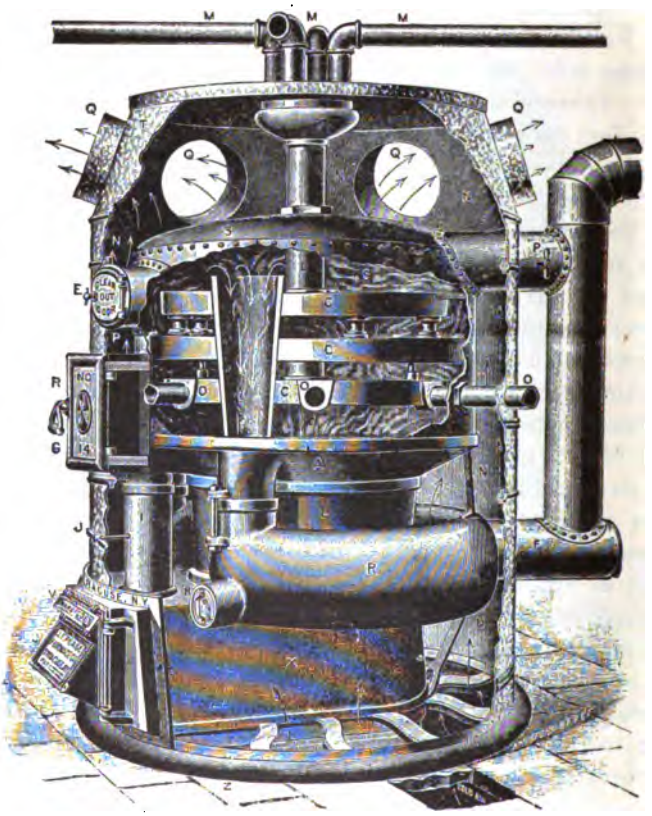


FIG. H.—Economy combination heater, low-down pattern; one or three sections.

is larger than in any of the other furnaces described. The fire pot is cast iron.

There is another form of this furnace, known as the low-down pattern, which has a horseshoe flue at the base, but the construction is quite different. There is a single down flue which extends up within the steel drum and carries the smoke downward through the bottom of the drum and into the return flue below. This construction is shown in figure H, which represents the Economy combination heater, for air and hot water, the water sections, C, C, C, being introduced

within the drum. Precisely the same construction is adopted for heater with air and steam as in figure I, except that there is a steam chest with a safety valve introduced in the space above the drum, within the casing.

We have now to describe a form of furnace which is quite original in design, and which embodies features to be very highly commended. This is the Farquhar's seamless furnace, made by the Farquhar Heating Company, of Chicago, Ill. The furnace is represented in figure J

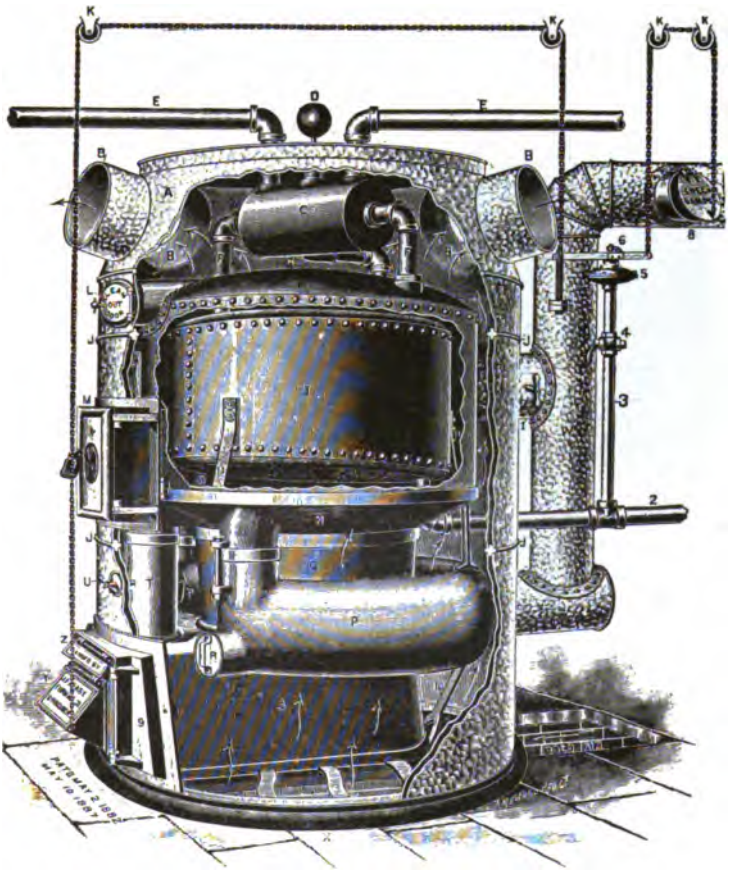


FIG. 1.—Economy combination heater, low-down pattern; steam and warm air; for hard coal.

and an interior view is given in figure K. Having had an opportunity to examine this furnace in operation, I deem it worthy of a somewhat extended notice. The seamless feature is intended to prevent the possibility of the escape of injurious gases into the warm air. This result is attained by extending the edges of the sheet-metal outward and joining them outside the casing. The security against the escape of gases is, therefore, independent of either workmanship or of the durability of the joints.

By reference to figure K it will be seen that the interior of the furnace is occupied by a large and thick fire pot and a combustion chamber constructed of fire brick. This fire brick is oval in plan and arched in section, only a narrow, longitudinal opening being left at the top for the escape of the products of combustion. A further very important feature of this part of the furnace is the construction of the fire-brick walls. These are hollow and provided with air ducts or passages, through which air is admitted by a special valve in front, and becoming highly heated is delivered in a thin sheet into the combustion chamber, where it mixes with the unconsumed gases and completes the combustion in a most effectual manner. The narrow openings in the walls of the combustion chamber are to be seen in the illustration (fig. L), immediately below the mixing chamber. The hot air enters with force, as though blown in by some blast apparatus, and while the space immediately above the bed of coal may be quite free from flame, where the gases come in contact with the blast of air they burst into the flame and intense heat is produced. It thus appears that the action of this furnace is to first convert the fuel into gaseous products, either by distillation, as when bituminous coal is freshly put on, or by partial combustion by admitting a limited supply of air below the fuel, and these gases, in a highly heated condition (the heat being maintained by the very hot fire-brick walls), are consumed by the hot air and become a direct source of heat. The valves which regulate the supply of air are closely fitted, so that the combustion can be practically stopped as long as they are closed, while the large body of lighted coals, protected from cooling by the thick fire-brick walls, will remain incandescent for many hours. Thus the consumption of fuel can be tested nicely and easily controlled. When the dampers are closed the quite of heat up the chimney practically ceases. It is all retained the steel and there is not sufficient movement of the air at of the drum and into the reach the anemometer. Following the shown in figure H, which represents escape through the narrow apertures for air and hot water, the water sect will be seen that they spread

FIG. J.—Farquhar's seamless steel furnace, portable form; five sizes.

out into the space above and come in contact with the inside surface of the seamless heating plate. Being quite free to expand they exercise no pressure, but as they cool they gradually sink toward the bottom. In doing so they are brought into closer contact with the heating plate, and part with their heat gradually to the plate as they descend. The cold air coming in below, on the outside of the plate, meets first with the temperature imparted by the cooler gases within, and comes in contact with the more highly heated part of the plate as it rises. Finally, the gases pass off below to the chimney flue at the back.

The two features of this furnace which are the most noteworthy are, first, the perfection of the means of effecting the entire combustion of the fuel, and, second, the manner in which the hot gases are made to give up their heat to the metal surface, at about the rate at which the circulating air can absorb it.

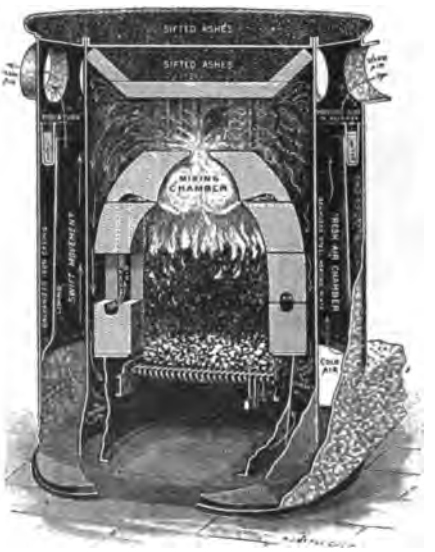


FIG. K.—Farquhar's seamless steel furnace; warm air. Interior view from the front, showing combustion and heating chambers.

It is but just to add that the makers of this furnace were very desirous to have its merits tested in the most critical manner, under the auspices of the awards department of the Exposition, all expenses in connection therewith to be borne by themselves. It is unfortunate that such work could not have been undertaken, but it was found to be quite impracticable.

The seamless warm-air furnace is readily converted into a combination warm-air and hot-water heater by the substitution of a simple boiler in place of the receptacle for sifted ashes on the top. But if it should be desirable to add still more to the hot-water efficiency, this may be done by introducing the vertical-tube circulators which are represented in figure L. These are attached to the bottom of the boiler in such a manner that they extend down on either side of the fire-brick chamber.

The Kelsey corrugated warm-air furnace, manufactured by the Kelsey Furnace Company, of Syracuse, N. Y., is another new departure in the making of warm-air heaters. This furnace is represented in figure N. It consists of a series of vertical, corrugated, cast-iron tubes of the form well shown in the engravings, which form the outside of the fire chamber. The air to be heated passes up through

these tubes, while the products of combustion make their way up between them, and passing outward through the small openings between the tubes at the top, descend around the outside on their way to the chimney. This furnace is, unquestionably, a very efficient heater. Each section has 8 feet of heating furnace, and as combined in a furnace, the heating surface of all of them together is very large compared with the grate area.

It may be objected to this furnace that it is made of cast iron, but while it is admitted that one might feel more free to recommend a furnace made of some other material, yet the construction of this heater is such that there does not seem to be the same liability of the leakage of gases at the joints, as may be observed in the usual constructions. There is no dome in which pressure can be produced, the draft is unobstructed, owing to the absence of tubes or bends, and at no place are the gases confined. The manufacturers may yet find it advisable to adopt some other metal for the heating tubes, which will enable them to make the heater lighter and fully as effective at a reduced cost, even though it should involve the use of a fire-brick lining for the fire box.

FIG. L.

FIG. N.—Kelsey furnace.

A novel form of stove, known as the "Keidel Patent Ofen," was shown in the form of a model, in the mining building, by Messrs. Keidel & Co. This Keidel's patent stove is made by three or more different establishments in Germany, and would seem to be very popular there. It is a magazine burner represented in figures O and P, which feeds down on one side into a horseshoe-shaped grate.

Back of

the magazine, occupying about one-half of the upright section, is the fire chamber where the combustion of the gases takes place. This, continued upward into the top of the stove, is the smoke flue, which there turns downward and joins the chimney flue about opposite the feed door. In this stove the combustion of the fuel takes place from the bottom of the column, which extends down from the feed door. The front portion of the grate runs downward as a continuation of the inclined plane down which the fuel is fed from the magazine, and in this position it divides the horseshoe grate about across the middle, but in colder weather, when a larger body of coal is necessary, this part can be swung outward at the bottom so that the grate surface can be utilized.

FIG. O.

This stove can be set for use as an ordinary heating stove, or it may be inclosed within a casing, when it becomes an excellent heater as well as a ventilating stove, the air being taken from without and well warmed before it is delivered into the room. Judging from the model and from the excellent descriptive circular issued by the makers, in which the results of calculations of heating power are tabulated, it would appear that the stove is an admirable heater, although it is not so attractive in appearance as it should be for home use.

FIG. P.

The German practice, as illustrated by this exhibit, is somewhat different from that already advocated in this report for heating by furnaces. It is to heat a large volume of air in a roomy chamber to a moderate temperature. This is preferably done by placing the stove or heater within a brick chamber of considerable size. This chamber should be large enough to permit one to enter it for cleaning the space of dust, and it is well to line the chamber with glazed brick. In this country the practice is to filter the air before it enters the casing. One objection to the German plan is that much of the heat is absorbed in warming the brick casing. Whether this is a serious objection or not in practice can not be known without experimental tests. However, we have not only to consider in this connection the heating of the air, whether it is to be a small volume or a large one, but also economy in the use of fuel. Not to repeat the arguments already set forth, it need only be said once more that the more rapidly the current of air moves against a hot surface the better the heat is utilized.

B. HOT-WATER HEATERS, STEAM HEATERS, AND RADIATORS.

Among the hot-water heaters exhibited there were several which represent radical changes in construction and increased efficiency. Among these the Watson and the Chapman heaters deserve very high consideration, especially for the excellent devices to insure good combustion by the intimate admixture of heated air with the smoke and unconsumed gases above the fire.

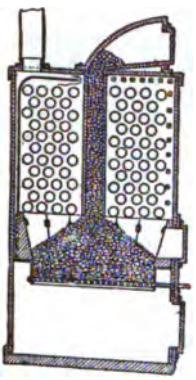


FIG. Q.—Vertical section, showing fuel in fire box.

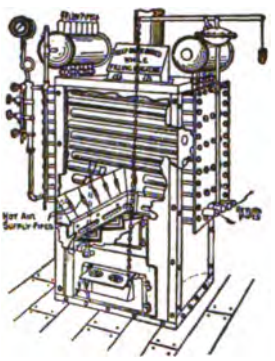


FIG. R.—Perspective view, showing portion of fire box, grate, and hot-air supply pipes.

FIG. S.—Perspective sectional view of body of boiler, showing it stripped of all movable parts.

The Chapman combine boiler is a portable, sectional, magazine, steam and hot-water boiler, for heating or for steam power. It is represented in figures Q, R, S, T, and U. The water tubes extend across the boiler, above the fire, and through the fire chamber, on either side of the rectangular magazine. The tubes open at each end into a common water chamber which constitutes the wall of the fire chamber. The essential features of the boiler are well shown in the cuts. The rocking, dumping, zigzag grate is made to rest upon iron castings, which are provided with openings through which air is admitted to the fire immediately above the grate. This construction adds to the air space of the grate area, and is designed to maintain good combustion around the edge of the fire. In addition to this, the fire box is

FIG. T.—Enlarged detail of hot-air pipes.

FIG. U.—Showing supplemental deflecting plate.

made flaring, with firebricks which are perforated. The perforations bring heated air from the ash pit and deliver it above the fire, where it mixes with the coal gases and assists their combustion. The objects which the exhibitor has endeavored to attain, viz, economy, simplicity, strength, free circulation, and easy access to all parts, seem to have been in a great degree realized.

The Watson perfect combustion furnace is represented in figures V, W, and X, applied to a sectional boiler. The boiler itself is com-

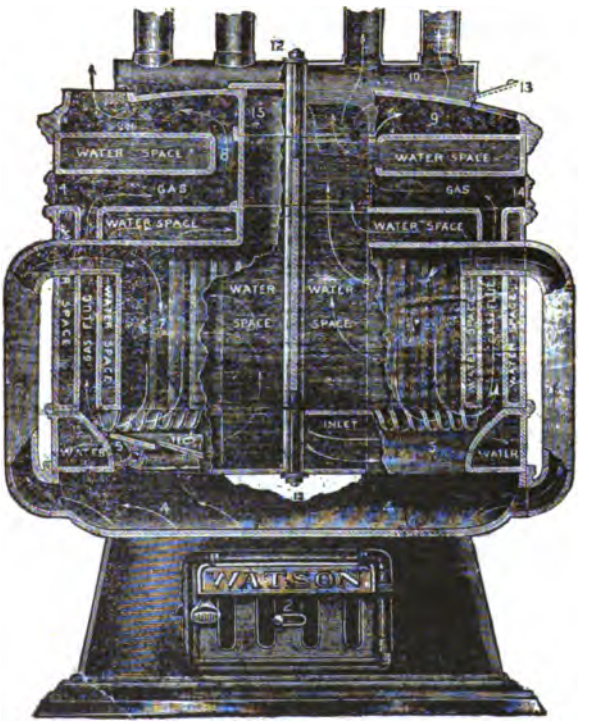


FIG. V.—Watson perfect combustion furnace.

1, base of furnace and ash pit; 2, ash door; 3, draft door; 4, space beneath the grate where air is heated to supp y air tubes; 5, feed water section; 6, air tubes to convey heated air to fuel above the grate; 7, interior of fuel chamber; 8, top-water section; 9, top of furnace covering water sections; 10, header; 11, grate on which coke fire is supported and through which air passes to support combustion on same; 12, studs at top and bottom holding water sections together; 13, draft regulator; 14, clean-out doors; 15, fuel magazine.

pact and admirably constructed, with a central fuel feed, differing from the usual sectional boiler in the course of the water through the sections. The sectional view is intended to indicate the course of the products of combustion. Air is admitted through the ash-pit chamber when it is heated, and while a portion thereof goes to support combustion in the bed of fuel, another part ascends through the lateral passages on either side of the boiler, and passes over into the combustion chamber, above the fuel, when it mixes with the smoke of unconsumed gases. The

mixture of gases and air is then drawn downward through the incandescent coke around the edges of the fire pot, where combustion is perfected, and the hot gases then pass upward through the flues in the water section shown in figure X, which surrounds the fire chamber. This is a most excellent heater. The self-feeding arrangement avoids the feeding of cold fuel to the fire, therefore combustion is uniform and there is no time when smoke is produced by the rapid distillation of fresh coal, the process of coking being gradual as the coal descends. Sufficient air is always available for complete combustion of the gases produced and the heat produced is well utilized.

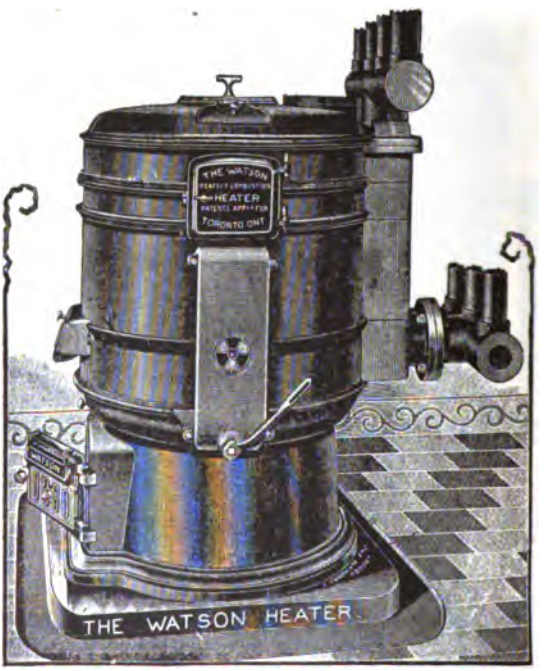


FIG. W.

The Oxford heater exhibited by the Gurney Hot-Water Heater Company, of Boston and Toronto, is represented in figures Y and Z. It is a sectional heater, the construction of which is clearly shown in the figures. The fire-pot section is hollow, with a ribbed inner surface, larger at the grate than above, allowing ashes to readily fall through. The return water flows through the fire-pot section, thence into the column at the back, from which it is free to enter any of the successive sections, or to pass directly into the heating pipes. The course of the water through the sections is clearly shown in figure AA.

The Buffalo heater, manufactured by Messrs. H. R. Ives & Co., of Montreal, is shown in figures BB to EE. It is rather more

compact than the Gurney heater, and differs from it in several particulars. The fire pot is corrugated and tubular, and is cast in one piece with the first section, into which the vertical tubes of the fire pot open directly. From this first section the water is free to pass through the header into the general circulation, or it may flow through the sections which are divided by horizontal diaphragms, as represented in figure DD.

A very excellent form of water heater is represented in figure FF. This is the Hub Hot-Water Heater, of the Smith & Anthony Stove Company, of Boston. The construction is admirable, the sections being joined with screw connections. The water circulation is con-

FIG. X.—Sectional view of water section forming fuel chamber cut away to show circulation of water and method of heating the same.

1, inlet for water supplied from feed-water section; 2, water outlet to adjoining water section; 3, water space; 4, inlet for heated air to support combustion of gases liberated above the fuel on grate; 5, opening to supply coal to fuel chamber; 6, flues formed between walls of fuel chamber through which the heated gases pass and thereby heat the water surrounding the same; 7, studs connecting water section; 8, diaphragm to divert water in water section.

tinuously upward. The same general plan is carried out in the Hub Steam Heater. It will be observed that the sections are entirely inclosed by the nonconducting casing, between which and the periphery of the sections the hot gases of combustion pass, and there is therefore no loss of heat by surface radiation. The Economy Hot-Water Heater, of the J. F. Pease Furnace Company, of Syracuse, N. Y., is also a variety of the horizontal sectional heater represented in figures GG and HH, which need no description. A modification of this construction is applied to the Economy Steam Heater, of the same company, in which the water fire pot is joined to a tubular boiler, as indicated in the figure II.

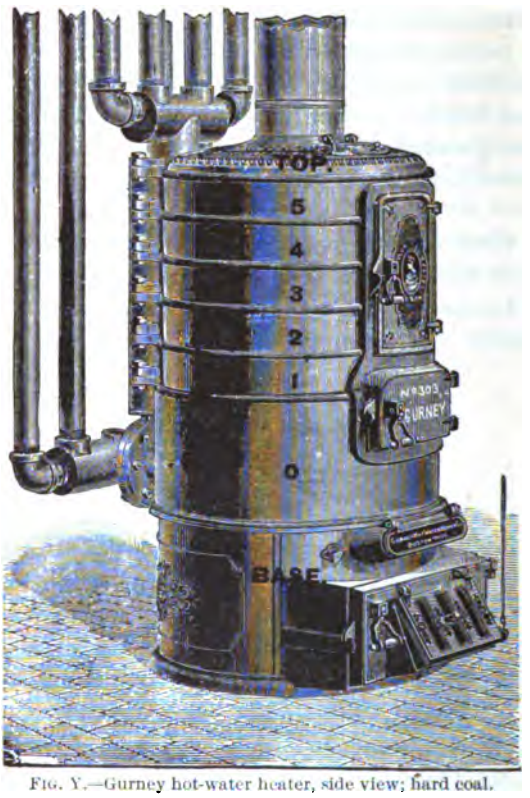


FIG. Y.—Gurney hot-water heater, side view; hard coal.

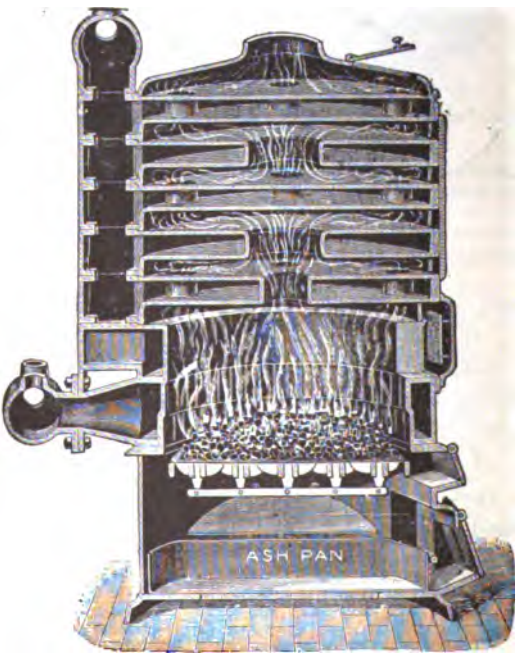


FIG. 2.—Gurney hot-water heater, sectional view; hard-coal burner.

Messrs. Abendroth Brothers, of New York, exhibited the Andrus Water Heater, a horizontal sectional heater, which is very compact and portable.

Among the tubular heaters, that of Chapman has already been described. The American Heating Company, of Rockford, Ill., exhibited one of its "Circulator" Hot-Water Heaters, represented in figures JJ. In this there is a water fire box and a water back which is divided into two chambers, B and E, the former being the cold-

FIG. AA.—Gurney hot-water heater; hard-coal sections.

Nos. 2 and 4, section showing circulation of water and back connection; Nos. 3 and 5, section showing flues and circulation of water; No. 0, fire-pot section, showing circulation of water.

water chamber, communicating with the return pipes AA, etc., and the latter the hot-water chamber, communicating with the flow pipes II. A series of pipes D are attached to the inner wall, and open into the hot-water chamber E of the water back. They are closed at their free ends. A corresponding series of small pipes C are attached to the partition, between the chambers B and E. They are open at both ends and extend through chamber E into pipes D, nearly to their closed ends, and furnish a free passage from chamber B into the pipes D.

The fire pot, G, is shown with sections cut out. It is so constructed as to contain a water chamber, which allows at all times a free circulation of water throughout, and, together with the pipes D, furnishes the heat-absorbing surfaces of the heater. The pipe F forms a

FIG. BB.

FIG. CC.

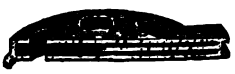


FIG. DD.—View of sections.

connection between the cold-water chamber B of the water back and the water chamber of the fire pot. The pipe H makes connection from the water chamber of the fire pot to the hot-water chamber E of the water back.

In the Canadian section was shown a tubular heater devised by Mr. D. K. Strachan, of Goderich, Ontario. There are water chambers at each end connected by boiler tubes expanded in. The most novel feature of this heater is the cleaner, which,

FIG. EE.

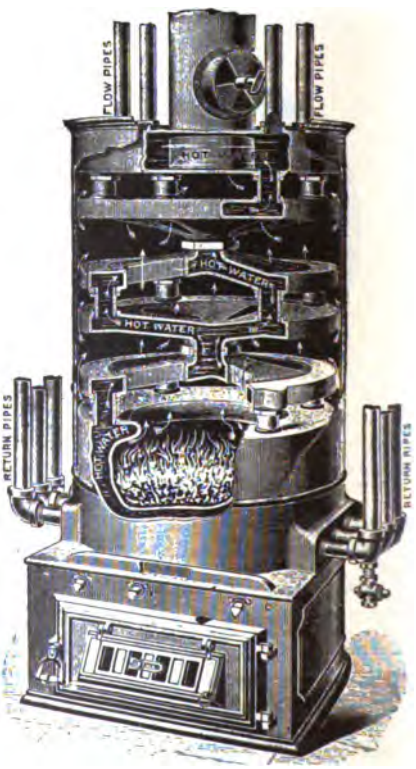


FIG. FF.—Hub hot-water heater.

when moved back and forth, effectually cleans the tubes on the outside,

while the cleaner acts also as a damper for indirect draught. The fire pot is entirely surrounded by water.

There was also in the same section a hot-water heater exhibited by Mr. Nicholson, of Goderich, Ontario, constructed entirely of steel, particularly adapted to the heating of railway cars and stations. The fire is entirely inclosed in a water jacket, and water tubes cross the combustion chamber from side to side immediately above the fire.

The Gorton & Lidgerwood Company exhibited an upright steam tubular boiler, especially designed for heating purposes, which is

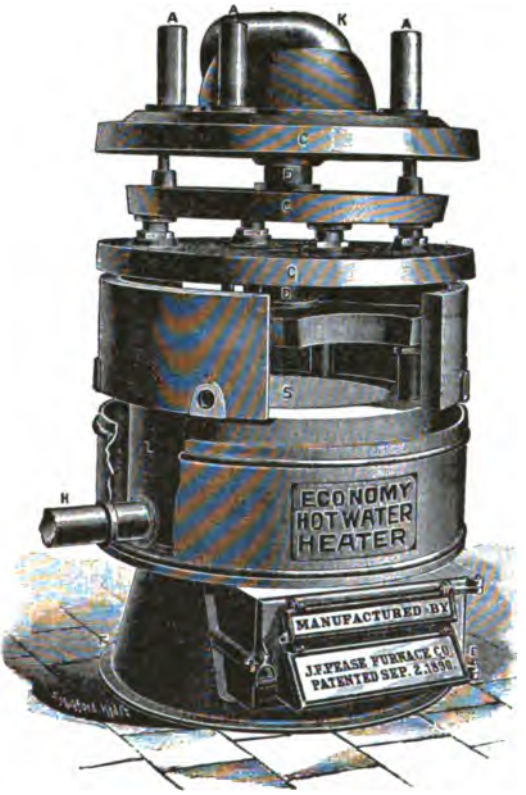


FIG. GG.

specially noticeable for having a magazine with side feed pockets, as shown in figure KK. This is a good feature because, generally speaking, economy results over any system of intermittent firing when fuel is fed continuously to a fire.

Two forms of vertical, sectional hot-water heaters were exhibited of the same general plan, but widely different in construction.

Of these, the "rapid-circulator sectional boiler" of J. W. Warner, of Oneida, N. Y., deserves first attention. The method of joining the sections to make a boiler of any desired capacity is admirable. It will be seen from figures LL, NN that each section carries a hollow water-

circulating grate bar, and as the boiler is lengthened the grate surface is correspondingly increased. Special sections are made, however, which enable the fire to be divided into two parts, and a self-feeding arrangement can be introduced at either end. The free and directly upward course of the water circulation through the large conductors is shown in figure MM, and the comparatively large surface exposed to direct radiation from the fire and to the course of the hot gases is obvious from figure NN. It is claimed that each section exposes 20 square feet of heating surface, 50 per cent of which is exposed to direct radiation. The top drum may be made in sections to give sepa-

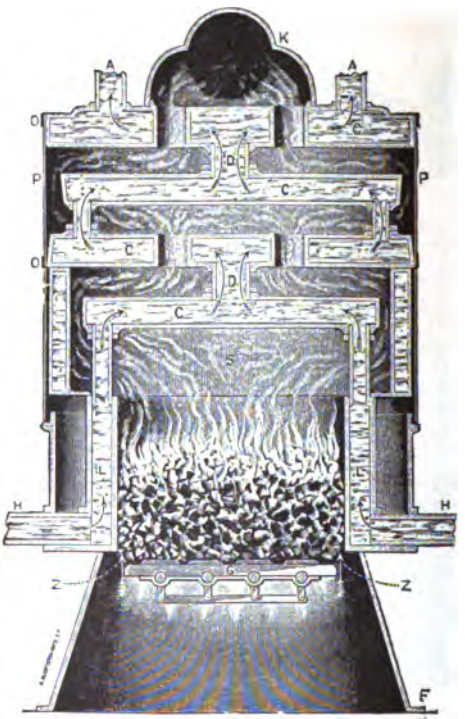


FIG. HH.—Economy hot-water heater.

rate currents of circulation, thus making it possible to send the hot water directly to remote parts of a building, while other lines may run to nearer points or in other directions. The boiler can be readily cleaned, and all joints and connections are accessible on the outside. This boiler can also be used for steam heating.

The Gurney double-crown hot-water heater is represented in figures OO, PP. It is also a vertical sectional boiler. The construction of this heater is so clearly shown by the cuts that further description is unnecessary. It was shown in the Canadian section. The sections are nippled to headers at top and bottom, and the point is made that the

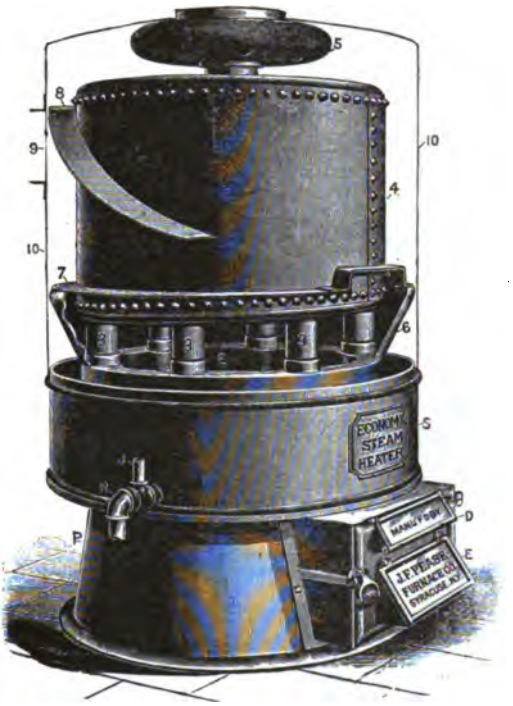


FIG. II.—Economy steam heater.

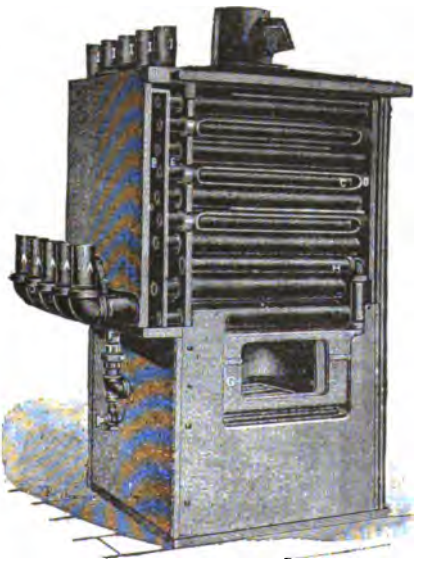


FIG. JJ.

water is heated as it rises in the sections in such a manner as to meet with the greatest heat at the point of delivery at the top.

The combination heater and range of the Wilcox Water Heater Company, of Chicago, is a new departure in heating worthy of consideration. It is represented in figures QQ, RR. The fire pot is circular, of

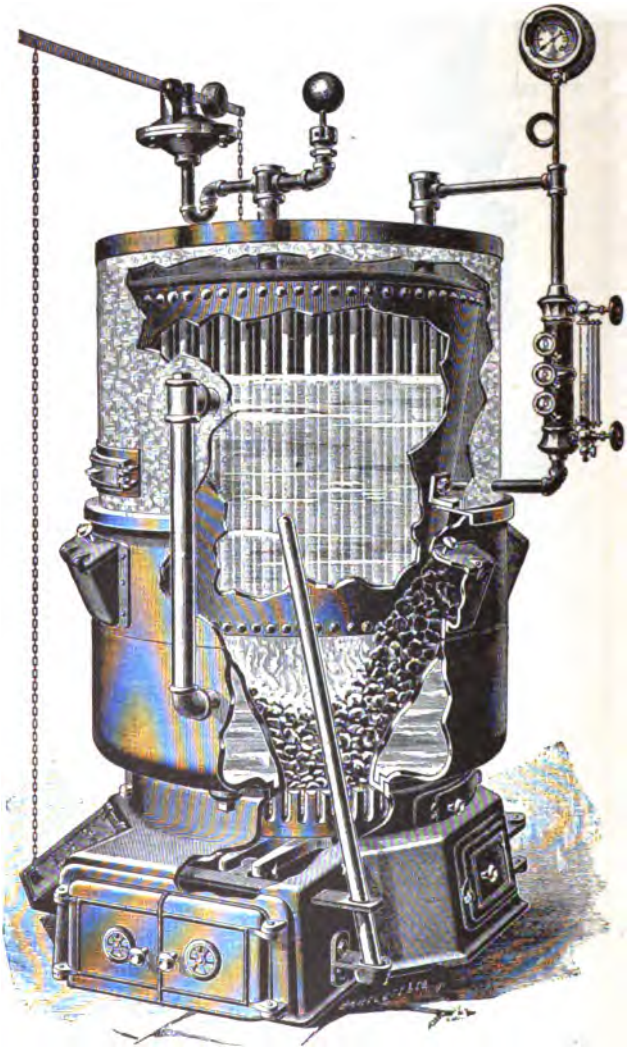


FIG. KK.

large size, and is intended to afford heat for cooking purposes, and at the same time to heat water in the spiral pipes for warming the house.

The front griddles are directly over the fire, always hot. The others can be heated quickly by turning the damper. The heater proper consists of a sheet-iron jacket lined with nonconducting material, which effectually prevents the escape of heat in the kitchen. Inside

FIG. L L.—Boiler for hot water.

A A A, boiler sections; B, reservoir door; C, damper rod; D, flue cleaning door; E, fire door, both front and rear; F, ash pit and draft door both front and rear; G G, shaking grate bars; H H H, side cleaning doors; h h h, brush openings; I I I, grate connections, inlet circulation; J J J, grate connections, outlet circulation; K, top drum; L, lower drum; M, smoke flue and damper.

FIG. M M.

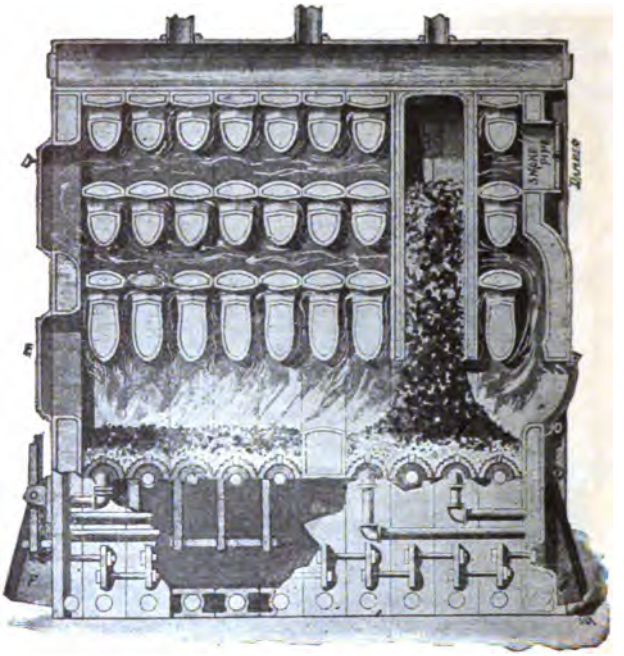


FIG. NN.

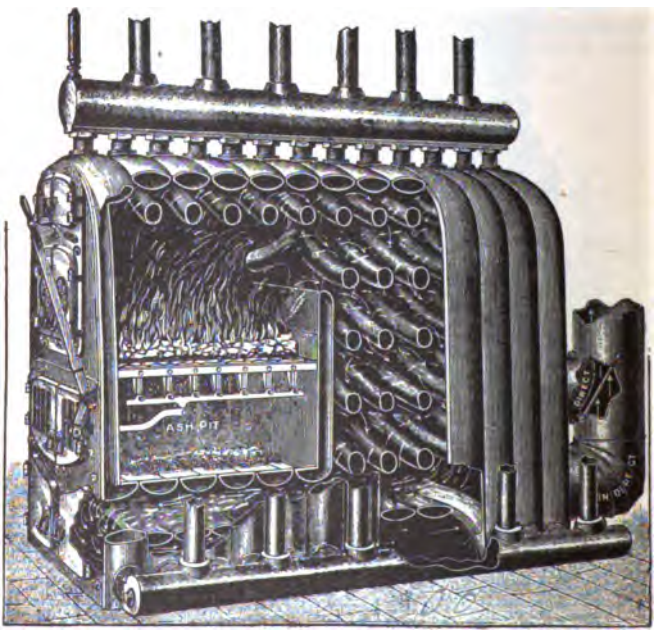
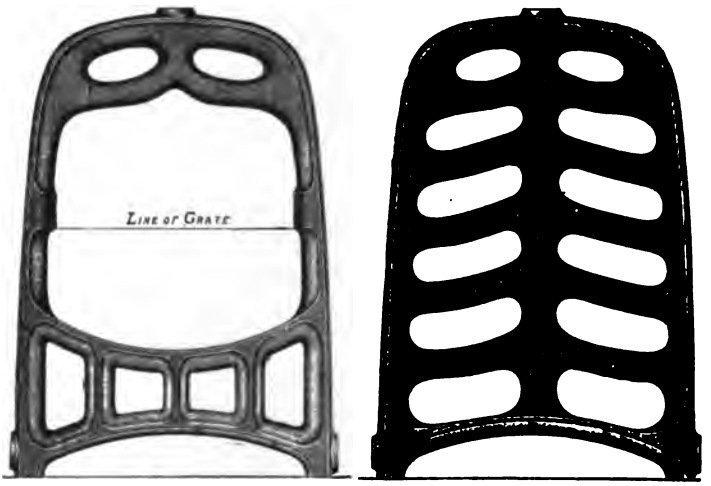


FIG. OO.—Sectional view of Gurney "double-crown," style "C," hot-water heater.

this jacket are a series of coils made of wrought-iron pipes inclosed in the hot-air flue, in which the heat is compelled to follow the coils.



Section showing fire box. Section showing combustion chamber.

FIG. PP

The heat is all taken up by the water coils before it reaches the top of the jacket, where the smoke passes into the pipe leading to the chim-

FIG. QQ.—Front elevation view of No. 4 heater.

ney. A coil around the fire pot, connected with the ordinary kitchen tank, furnishes an abundance of hot water for baths, dish and clothes washing.

A plate is provided for use in warm weather which permits only one-half of the fire pot to be used. A portable oven is furnished.

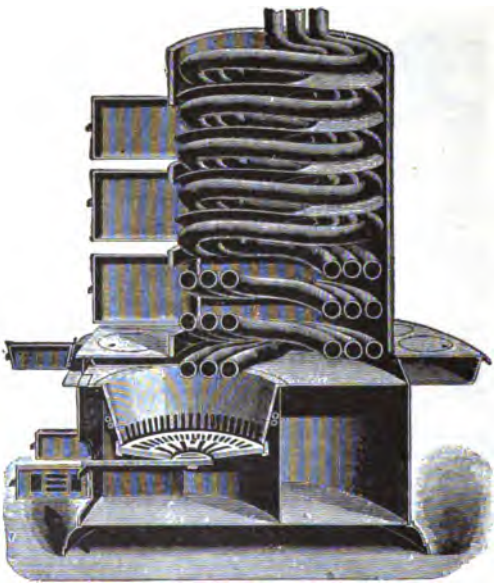


FIG. RR.—Sectional side view of No. 4 heater.

RADIATORS.

The exhibits of radiators are worthy of special mention for the elegance of display as well as for the article shown. The American

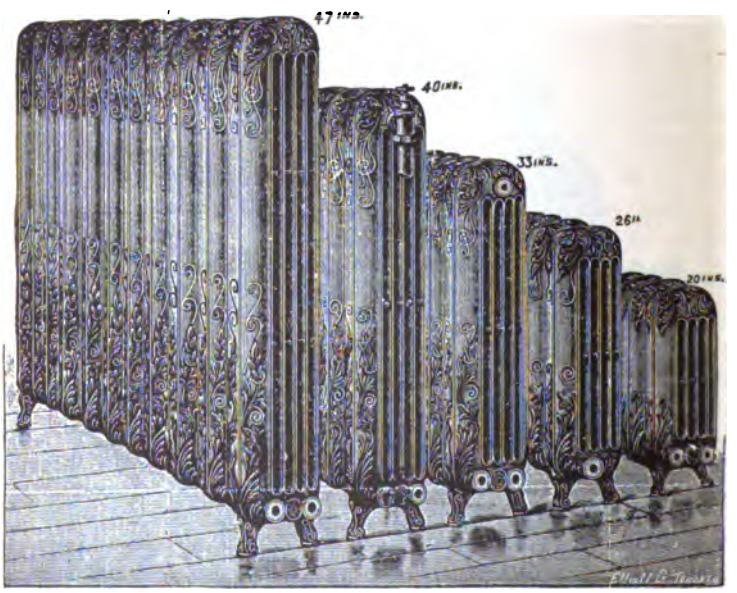


FIG. SS.—Yale Quintet.

Radiator Company made the finest display, and the beautiful designs and excellent workmanship are worthy of high praise.

The A. A. Griffing Iron Company, of Jersey City, was very much restricted in space. Although the exhibits were crowded together, they were all of the highest excellence and beauty. Especially noticeable were the Bundy Renaissance, the Bundy Elite, the Pyro Wall, and the Columbia, the last of an entire new design.

The Gurnney Company, of Toronto, exhibited a form of radiator recently introduced, having five bars—the Rugby Quintet—which gives a relatively large radiating surface. It is represented in Figure SS. The same company also showed a hot-water radiator of beautiful design, with a top feed.

C. PARLOR STOVES, FIRE-PLACE HEATERS, OPEN GRATES.

Although it is well known that the only possible manner in which a room or a series of rooms can be equably and comfortably heated, even if we disregard economy entirely in the matter, is by a properly devised system of ventilation combined with heating, the fact that there are only two forms of heaters in the exposition which can make any pretentions to a scientific application of present knowledge on this subject is more significant than creditable to our stove manufacturers. I refer to the Cortland Howe ventilating stoves, and the Jackson ventilating grate. It is true, there were many exhibits of stoves which remained as a sealed book to the judges in this department, having been withdrawn from examination by the exhibitors, but it is perfectly safe to assume, from the nature of the case as well as from cursory observation, that if a manufacturer had any new and valuable feature in any of his productions he would discover some means whereby it could be brought before the judges for examination. It is also a reasonable conclusion, founded upon experience with mankind in general, that there was nothing worthy of special note among the exhibits withdrawn from examination, it being a fully recognized fact that specific points of merit or advancement would be sure to secure recognition.

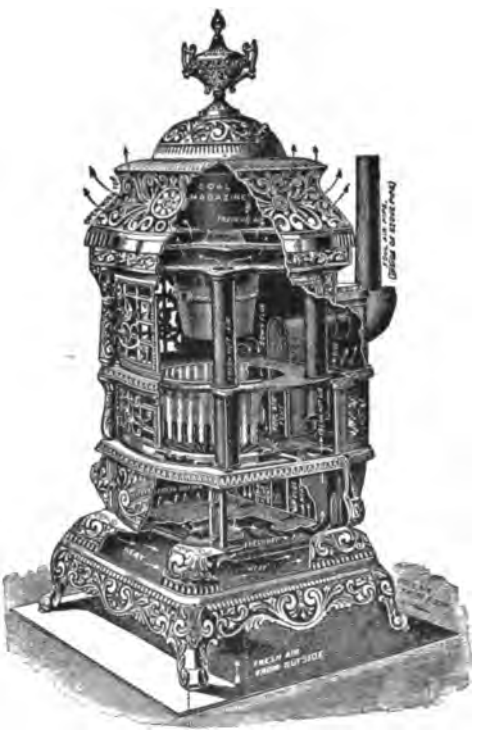


FIG. TT.

The Cortland Howe ventilating stove, manufactured by the Cortland Howe Ventilating Stove Company, Cortland, N. Y., has only recently been perfected, after much experience and many improvements in construction. It is represented in figure T T, which shows the system of air circulation through the stove, and also the flue which carries the foul air away from the floor and delivers it to the chimney. The principle of this stove is strictly correct. Fresh air from the outside is delivered to the bottom section of the stove, beneath the ashpit, and from there it ascends through pipes set in four corners of the fire chamber, as shown in the illustration. In this manner a large volume

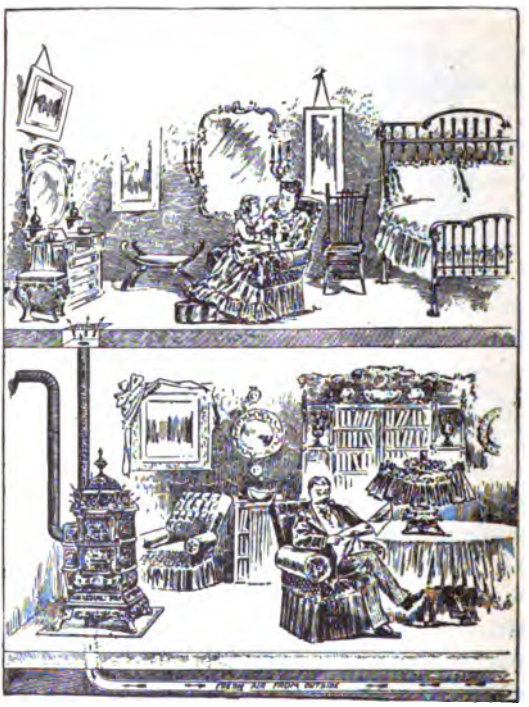


FIG. U U.—The Cortland Howe ventilator.

of fresh air becomes heated and is delivered from the top of the stove to warm the room. In addition to this, the heat of radiation from the stove is also added to the warmth of the circulating air. In this form the stove is superior to most parlor stoves because of the excellent means for heating the air. But the ventilating device adds very much to the heating power as well as to the purity and healthfulness of the air. This device consists of a foul-air tube within the body of the stove, as shown in the cut, which is connected with the smoke flue. It will be observed that this pipe takes up foul air from the floor and discharges it into a smoke flue in a heated condition, and it does not, therefore, interfere with the natural draught of the chimney as would

be the case if the duct were led up outside of the stove. The intention is, that as much foul air shall be taken out of the room as there is fresh air admitted and warmed by passing through the stove. In this manner there is a constant circulation maintained throughout the apartment and uniformity of temperature secured which would be impossible without the ventilating feature. The design and construction are to be most highly commended. The stove is a base burner. It has been submitted to practical tests on several occasions by scientific men, whose reports bear testimony to the efficiency, uniformity of temperature, and economy of this stove.

FIG. V V.—Grate with bar fender.

Figure U U shows the application of the stove to the heating of an upper room, which is entirely practicable with a stove of this kind, because of the great volume of air that can be warmed.

The Jackson ventilating grate, represented in several aspects in figures V V to Z Z, is manufactured by the firm of Edwin A. Jackson & Bro., of New York City. These grates are made in great variety of external design and decoration, but in principle they all conform to the same general type, which is that represented in figure W W, showing the back of the fireplace. It will be seen that there is an opening below for the fresh air, which must be admitted from outside. The air passes upward and is heated by contact with the projecting spurs until it finds an outlet into the room between the five smoke flues and through the open metal work or register, shown in the front view. Another form, shown in figure Z Z, is intended to afford a connection of warm air to a room above. The other illustrations will be sufficiently well understood from the legends accompanying them.

FIG. W W.—Concord, back view.

The feature of this grate is perfect ventilation. As fresh air is admitted from without, it becomes well warmed. With an ordinary

grate the air that enters the room is drawn in cold through doors, cracks, and crevices, and makes its way directly to the fireplace, escaping into the chimney as soon as possible. With the Jackson grate the warm, fresh air spreads uniformly through the room, taking the place of the cooler, foul air which passes into the fire to support combustion. The heating chamber at the back adds very much to the economy in the consumption of fuel.

It will be observed that the back and the ends of the fireplace are studded with projections, which add very much to the surface exposed to the air in its ascent. The back is a solid casting, which does not

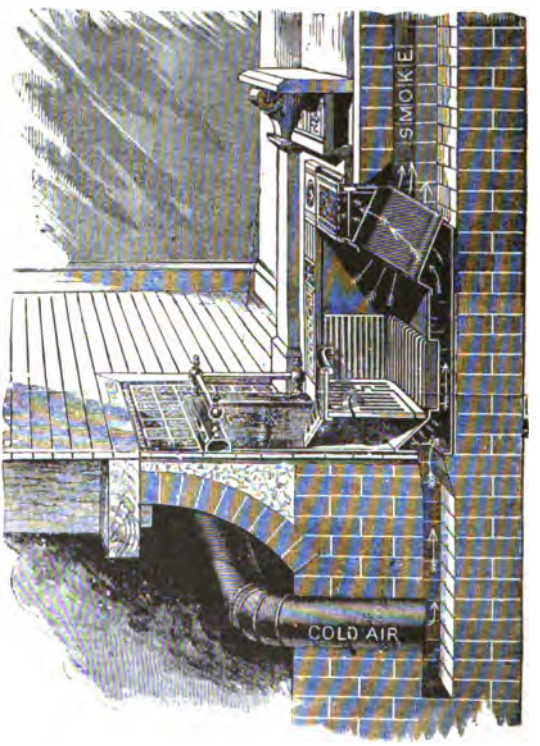


FIG. X X.—Section showing manner of constructing the fresh-air duct when the fireplace is situated in an interior wall of the house.

crack nor burn out, because of the cooling effect of a free circulation of air on the exposed surface.

It is claimed by the manufacturers, doubtless with entire truth, that this grate will accomplish more heating than three ordinary grates of the same size, while, in addition to this, it is an excellent ventilator.

In this connection it is proper to remark that, although the ventilating fireplace in many different forms has been before the world a long time, some with hot-air chambers, others with flues in the chimney, vertical pipes, horizontal pipes, pipes above the fire and back of the fire, and in every conceivable position and form, yet, in this

advanced age of scientific knowledge and domestic economy, we seldom meet with anything more than the ordinary fireplace, built with full regard to excellent draft, which is tolerably certain to carry the smoke and a great volume of air up the chimney. The open fireplace is regarded as a health-giving heater. The blaze is cheerful, and we all like to gather around it in the evenings, and to watch the glowing embers. But how often it happens that we feel the need of another fireplace to warm our backs. We burn tons and tons of coal from which we derive but very little benefit, because we depend upon the radiant heat of a cheerful fire. We are trying to do what is impossible. Radiant heat will not warm a room. Hold a thermometer before a grate fire and it will go up, as the heat of the fire warms it, to a degree depending upon the distance of the fire. Interpose a bit of cloth between the fire and the thermometer, and the effect of the fire in warming the air will be scarcely noticeable. Moreover, the ordinary open grate draws the air out of a room and sends it up the chimney, while fresh air from some source must come in to take its place. If the fresh air can be delivered into the room warm from a furnace, then the fireplace may operate as a ventilator, and such ought to be its office at all times. Unfortunately, however, the fresh air does not usually come in through registers, but it is drawn in through the cracks of doors and windows, often freezing cold, and this is the reason why the ordinary open fireplace is so inefficient as a heater.

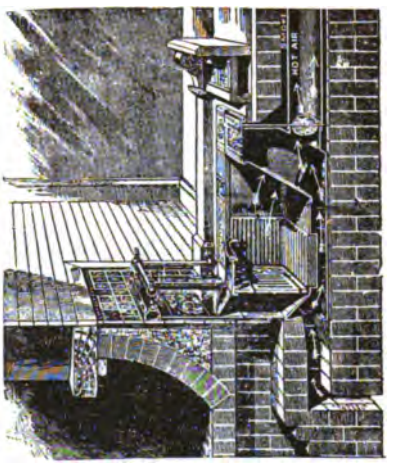


FIG. Y Y.

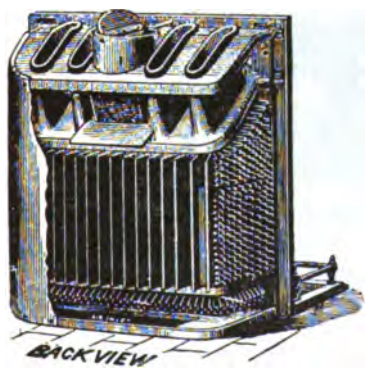


FIG. Z Z.—Back view, with outside covering broken away to show air chamber.

We have an example of this in the exhibits of Messrs. Steel & Garland, of Sheffield, in the British section of the manufactures building. This exhibit consists of six improved domestic fireplaces, for which the exhibitors claim great heating power and economy of fuel, perfect combustion, and consumption of smoke, the latter claim being based upon the brick back "made to project over the fire to deflect the heat which would otherwise pass up the chimney, and constitutes a heating surface by which the gases are at once

ignited and the smoke consumed." Having studied over this presentation of the case for some time, I am still at loss to discover wherein this fireplace is in any wise superior to or different in principle from many others which have been long known and in use in this country. The exhibit of Messrs. Steel & Garland is a very fine one from an artistic point of view, but no claim for advancement or increased efficiency can be sustained at this late day for any heater which does not utilize some portion of the heat of the fuel for warming the air.

FIG. AAA.—Magee Ideal, open grate.

The extravagance of the past can no longer be laid to ignorance. The Jackson grate is a type of what a fireplace heater should be, while all simple grates which have no provision for warming the air of a room should be discarded, except for ventilating purposes in connection with some other and sufficient source of heat.

Messrs. F. & L. Kahn & Bros., of Hamilton, Ohio, exhibited the Estate Oak stove, which is characterized by a jointless ash pit cast in a single piece, with well-fitted air registers with screw adjustments,

which afford perfect regulation of the draft, as when closed the ash pit is practically an air-tight box.

The Spicer Stove Company, of Providence, exhibited a number of parlor heating stoves of highly artistic design, with an excellent shaking and dumping draw-center grate.

FIG. BBB.—The Mistletoe.

FIG. CCC.—Magee Royal Standard.

The Magee Company also made a fine display of parlor stoves, such as represented in figures AAA–CCC.

D.—COOKING STOVES, RANGES, ATKINSON OVEN.

The exhibits of ranges are most naturally divided into two groups, viz, the cast-iron ranges and the steel ranges. Among the former, those manufactured by the Magee Furnace Company take the first rank by reason of their excellent finish, exceptionally fine castings, and good design. Steel ranges, however, are coming more and more into favor. They are stronger, less liable to break in transit or from the heat, and with the flues lined with asbestus they are more economical of fuel. Cast iron is still almost universally used for the tops of steel ranges, it being the opinion of most manufacturers that this is the only material which will withstand the heat to which the stove top must be exposed without warping from the heat itself or sagging from the weight of articles set upon it while hot. In the case of large ranges for hotels, which are subjected to very heavy work, and on which some of the plates require to be made of considerable size, cast iron is used by all makers, for the reason that any other metal would require to be made of such a thickness as to become inconveniently

heavy, as well as unduly expensive. But experience has shown that, except in this particular application for extremely heavy work, malleable iron is not only equally as good as cast iron, but it possesses certain advantages over cast iron for the tops of stoves and ranges.

Principal among these are its toughness, which renders the parts quite unbreakable in transport, and the light weight of the covers and centers. The credit of introducing the use of malleable iron for range tops in a commercial way belongs to the Wrought Iron Range Company, of St. Louis. The large business which they have established in the sale of their ranges made with malleable tops and trimmings is in itself sufficient evidence, not only of the favor with which they are received by the public, but also for the suitableness of the material used by them in the construction of their ranges, as evidenced by the continued and growing demand for them after a dozen years of practical use in hotels and in family kitchens. The extraordinary statements of the competitors of this well-established and reputable firm against the use of malleable iron, and the undignified methods which they have employed in endeavors to interfere with the trade of the company, justify a clear statement of the facts concerning the merits of malleable iron for stove manufacture. The writer has in his possession two malleable iron covers and a short center which have been in constant use for ten years, burning coal and wood, accompanied by an affidavit to the effect "that the top frame, anchor plates, short center, lids, and malleable parts are in as good condition, as level, and straight as the day it was put in our kitchen." In addition to this evidence, he has more than a dozen sworn depositions from as many different persons, certifying to the use of malleable range tops for varying periods, from several years to eleven years, declaring that the malleable-iron top plates, doors, and frames, have not warped.

In the face of such a mass of evidence from intelligent persons, based upon practical experience, and with due consideration of the well-known physical properties of the metal, it is impossible to overlook the claims of those who use malleable iron for ranges. The subject has been forced upon my attention as a judge of awards by the persistent efforts which were made by the cast-iron advocates, seemingly with the determination to prevent any award for the use of malleable iron.

The impression made upon the writer concerning this question of cast iron versus malleable iron is that the latter is a better metal for the purposes mentioned than the former, but it costs more, and can only be profitably adopted by manufacturers who can use it in large quantities and thus secure the advantages of the lowest contract price for the metal.

The reiterated assertions of the opponents of the use of malleable iron for ranges, that it will warp and get out of shape and burn out,

are therefore not well founded. The evidence is conclusive that it is entirely suited for the purpose in question, if properly applied; in other words, if the weight and thickness and shape be properly chosen and adapted to the special requirements. It is nevertheless possible that under the application of very excessive heat, such as would never be experienced in practice, malleable iron would not bear the same abuse as the heavy cast-iron plates with which it might be compared. But it is not a question of how much abuse the metal will stand, but rather it is whether it will stand the test of actual use, and it is this fact that has been established.

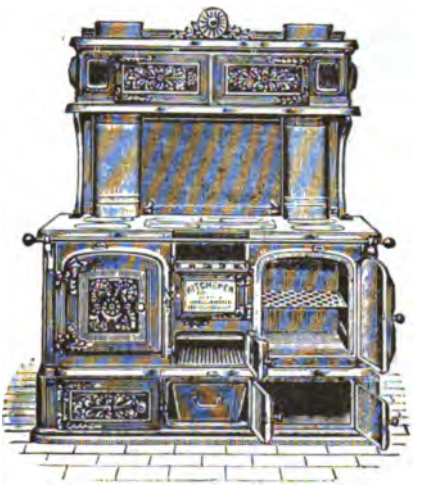


FIG. DDD.—Showing range with high and low closets in portable form.

CAST-IRON RANGES AND STOVES.

The finest cast-iron ranges, excepting the Nevins range, which is radically different in design, submitted to examination for award were those of the Magee Furnace Company, of Boston. Among these the Hotel Kitchener, Figure DDD, and the Grand are the most notable. The former is provided with ovens which can be taken out for repairs, or renewal, or to clean the flues. The Grand, Figure EEE, is a new design, with a newly patented dock ash grate so adjusted that it can be removed without disturbing the lining or water front. The water front is also new. It is set in the front of the fire box and permits of lining the front. The oven door is provided with a temperature indicator, which ought to be a useful addition. There is also an adjustable water tank at the back of the oven, which can be quickly and easily detached. Not much is to be said of the cast-iron stoves exhibited by foreign nations. The representation is not large, but stoves of this kind seem to be about the same the world over. In the Canadian section there was a very creditable display of stoves of various kinds by the McClary Manufacturing Company, of London, Ontario. This company exhibited a range with a

FIG. EEE.—Showing ornamental base, elevated shelf, and end tank.

circular fire pot so placed as to throw the heat equally upon the three front lids. It is a well-made stove.

In the Mexican section is shown a stove which seems to be a copy of one of our own designs, but of Mexican manufacture. It is a creditable example of industrial progress in that country.

In the section of Argentina there are two stoves by different makers, which are commendable specimens of casting. The one by Ghio Lineri is patterned after European styles, with some modifications. Beneath the grate is fitted a revolving coffee roaster. The other exhibit is by Paladino, doubtless copied from an English model. The commissioner informed me that nearly all the stoves now sold in that country are of home manufacture.

STEEL RANGES.

The largest and most attractive exhibit of steel ranges and kitchen appliances submitted for examination for award was that of the Wrought Iron Range Company, of St. Louis. These ranges are constructed of the best material, and are excellent in workmanship and design. They are characterized by the use of malleable iron for lids, centers, door frames, water backs, and wherever this metal has found suitable application. The flues are lined with asbestos, without an interior plate of metal. It is maintained by those makers, who place a sheet of asbestos between two sheets of metal and use this combination for the outer flue plates, that the asbestos is thus protected from injury in scraping the flues to clean them. On the other hand, it may be said that if such a combination plate be exposed to considerable heat, the inner plate becomes very hot, and is liable to be burned out, the asbestos acting as a nonconductor to retain the heat in the metal. The practice of different makers varies in this respect, and each one claims advantages for his own method. A malleable water back with a safety valve attached is used in these ranges. It is an admirable contrivance to prevent damage from the freezing of water. The exhibit embraced the following articles: Hotel range, family range, charcoal boiler, plate warmer, sand oven, carving and steam table combined, hotel urns, and egg boiler.

The Born Steel Range Company, of Cleveland, Ohio, exhibited a number of excellent steel ranges having several noticeable conveniences and attachments, among them the manner of balancing the oven doors, the manner of clamping the oven bottoms, swing doors of warming closet, with extra heavy interchangeable iron top plates.

In the exhibit of S. B. Traub, of Chicago, the most notable feature was the tiled oven bottoms, for which certain advantages were claimed.

There were many other exhibits of cooking stoves and ranges which were withdrawn from examination by the judges.

LAURA NEVINS RANGE.

The Laura Nevins range represents a new departure in the construction of cooking stoves. It is the invention of J. H. Nevins, and was exhibited by the Laura Nevins Range and Heater Company, of St. Paul, Minn.

FIG. FFF.—Laura Nevins range.

The main exhibit was in the manufactures building, but for some time a range was in actual operation in the annex of machinery hall. It is represented in Figs. FFF to HHH. The special features of this range are that it takes the air for combustion principally from the perforated top plate above the fuel, the products of combustion pass forward to the front of the stove immediately beneath the griddles, then turning back they are directed downward beneath the oven

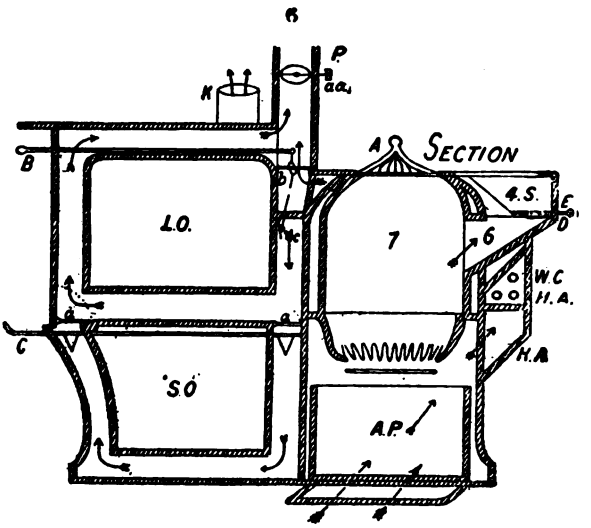


FIG. GGG.—Section description: Darts pointing upward, cold air from floor; HA, hot-air chamber, lower; HA, hot-air chamber, upper; WC, water coil for heating; 4 S, combustion flue; 6, dart, combustion escapement flue; 7, fire pot; A, perforated cover for down draft; aa, damper in pipe; P, opening for stovepipe; K, hot-air discharging pipe, air taken up at three darts at backs; LO, large oven; SO, small oven; C, duplex damper to heat lower oven; B, main or upper damper, automatic; AP, ash pan; E and D in fig. 1 is E and D in fig. 2, check dampers for portable oven and summer use; b, connection link to automatic dampers.

and around it, issuing at the smoke pipe, which is between the fire pot and the ovens. The circular fire pot is surrounded by a double hot-air chamber, in which air circulates twice around, and can be

utilized for heating either the kitchen or upper rooms. In addition to this, water pipes are coiled around in the air chambers, for heating the range boiler.

The down draft affords several distinct advantages over the usual construction, particularly in the economical use of fuel, and more especially when it is desirable, as in summer time, to make a small fire for a quick breakfast. With the fire pot almost full of ashes and cinders, a small fire can be made on top of these with a few pieces of kindling wood, which will generate a surprising heat, just where it is most required to do the necessary work. Moreover, the down draft carries off the odors of cooking. When the fire is very hot, the down draft acts to prevent the burning out of the top plates of the stove. In the ordinary construction the full force of the fire is directed upward against the stove top, but in this stove the burning gases are driven away from it. Another advantage is that the air for combus-

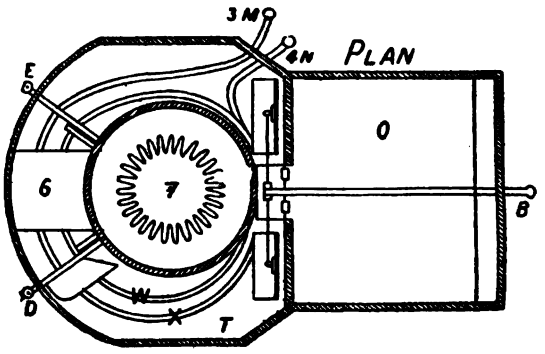


FIG. HHH.—Plan description: B, main damper, fig. 1; 3 M, water-pipe inlet; 4 N, water-pipe outlet; E and D, cheeks in front for summer use and portable oven; WX, water coil; T, hot-air chamber, upper; O, oven plan; 7, inside fire pot; 6, outlet for heat escapement.

tion is highly heated by passing over the top of the stove before it comes in contact with the fuel.

Some experiments were made with the range in operation in machinery hall annex to test its economy, and although they were only of the roughest description, the results will be given, copied directly from the original memoranda:

EXPERIMENT WITH THE NEVINS RANGE, SEPTEMBER 29.

A low fire had been in the range, which was drawn, and the fire pot filled with cold ashes below. Not sufficient ashes were put in for greatest economy. Dampers were opened and the lower drafts in front to start the fire as quickly as possible. Fire was kindled at 11.30 a. m. Weight of pine kindling, 4½ pounds; weight of bituminous coal, 8½ pounds; weight of anthracite coal, 17½ pounds. Kindling was lighted at 11.30, soft coal all put on, and in seven minutes the fire pot was filled with hard coal. More hard coal was added from time to time until it was all used. Heat was turned around the oven at 11.48, and in five minutes later oven temperature was 100°, and at 12 m. it was 260°.

Roast beef: A roast was put in the oven at 12 o'clock in a Stroud roasting pan, with a portion of boiling water in the bottom of the pan. · Roasting was finished at

1.45; well done throughout. Four pounds of potatoes were in the oven for three-quarters of an hour. Weight of beef before roasting, 7½ pounds; weight of beef after roasting, 7 pounds; loss, about one-half ounce to the pound. Water in 50-gallon tank was also heated. Air for warming the house showed temperature of 270° for considerable time. Unfavorable conditions of draft prevailed throughout.

September 27: Experiments of cooking a breakfast for five persons on the Laura Nevins range was made. The details are as follows: Pine kindling wood used for fuel, 3¾ pounds; fire lighted with paper, 9.40 a. m. Direct damper open and damper in pipe also open.

Potatoes boiled: Potatoes (sweet), 2 pounds; water for sweet potatoes, 3 pounds; put the above in covered tin. Boiling began at 9.49, and potatoes were done at 10.08. Cooked in twenty-nine minutes; boiled for nineteen minutes.

Coffee: Water for coffee, 3.5 pounds, boiled in eleven minutes (9.40 to 9.51). Coffee was not actually made.

Beef steak: At 9.40 a steak of 1.5 pounds was put over the fire on a broiler, using a few bits of wood to enliven the fire. The down draft carried all the odors into the stove. It was cooked in nine minutes.

Toast: After the steak was cooked bread was toasted.

There can be no doubt that this is the most economical kitchen range ever made. It burns either wood, soft coal, or anthracite; the fire is under perfect control and can easily be forced, with a reasonably good chimney, so that the fire will roar like a fireplace with a blower. This is a remarkable phenomenon to observe. The fire burns from the top. The draft does not pass down through the bed of fuel, as might be supposed; it only blows down on top of the fuel, as it were, and keeps the fire and the heat of the surface where it can be best utilized. If the top is closed, the range can be used with draft from below, the same as other ranges, and in practice I have observed that the lower drafts are often left open to hasten the combustion when a hot fire is desired. It is something gained when the housewife can get up in the morning and get the family breakfast without first cleaning out the ashes from the stove.

This range represents the greatest improvement in kitchen ranges that has been made in twenty years, and Mr. Nevins deserves the highest recognition for this work.

THE ALADDIN OVEN.

The Aladdin oven, devised by Mr. Edward Atkinson, of Boston, was exhibited in practical use in the Rumford Inn and in the Workman's Model House, erected by the State of New York. It is the result of years of experimenting by Mr. Atkinson for the improvement of methods of preparing food and the most perfect utilization of inferior kinds of food, especially the cheaper cuts of meat, which, by proper treatment, are converted into the most palatable, nutritious, and, at the same time, economical preparations for the table. The practical application of the principles of scientific cooking with the use of the Aladdin oven, as set forth by Mr. Atkinson, would not only enable the workingman to live much better than he does at present, but also

much cheaper, while the work of the kitchen is rendered less laborious and requires much less time and attention. A satisfactory description of the Aladdin oven would occupy too much space here, and the reader is referred to Mr. Atkinson's book, The Science of Nutrition. The special features of the oven deserve to be set forth, as a record of what has been accomplished, as follows:

Heat is applied scientifically, under constant regulation and absolute control, to the processes of cooking in such a manner as enables any person of common intelligence, after very little practice, to convert crude food material into appetizing and nutritious food in the simplest and most effective manner. In comparison with ordinary methods of cooking in iron stoves or ranges, in which it is extremely difficult, if not impossible, to control the variations of heat and the desiccating of the food, it effects the saving or the development of the specific flavor of each kind of food so as to make it more appetizing, while the food is rendered more capable of assimilation in process of digestion. It enables persons of small incomes to convert the tougher, and what are apt to be very much the cheaper, portions of the meat into tender and appetizing food, thereby rendering it possible to reduce the cost of nutrition in a considerable or large measure. It reduces the cost and the waste of the fuel, the work being done with gaseous or *liquid fuel*, from which the heat derived may be said to be boxed *up within the* walls of a nonheat-conducting case. It saves a great part of the time usually expended in supervising the process of cooking, while doing away with every cause of discomfort. Control is given by the use of this apparatus in the preparation of soups or broth for the sick, to the end that when the rules are followed such broth may contain the exact elements or proportions of the nutrients that are desired, without any substantial variation day by day.

With this apparatus set up in camp or in the house anywhere, bread of the best quality may be baked, meats may be roasted, simmered, or stewed, vegetables may be cooked, and in a pan containing a grill place on top of the tin tube, immediately over the lamp, steaks, chops, chickens, or game birds may be broiled in a perfect manner.

E. URNS AND KITCHEN ACCESSORIES.

Many of the kitchen appliances in the exhibition were assigned to different judges and were not examined by the writer of this report. Indeed, the only articles examined by him were those shown in connection with the range exhibits of two prominent manufacturers. Among these were the excellent copper tea and coffee urns for hotels with porcelain internal crooks to hold the liquids, by the Born Steel Range Company, and a very attractive exhibit of urns and other appliances for hotels, restaurants, etc., including boiler, sand oven, and a combination steam table and carving table, all of the most approved construction, by the Wrought Iron Range Company.

F. OIL, GAS, AND VAPOR STOVES AND HEATERS.

Two excellent forms of oil heaters were shown in the United States section, the Barler heater and the Edwards parlor lamp stove. The former is represented in figure III, and is doubtless the best heater of the kind in the market. It was shown by the Huett-Barler Manufacturing Company, of Chicago. The combustion is perfect, and there is no smoke or flame.

FIG. III.

The Edwards parlor lamp stove is quite different in design. In this (figs. KKK and LLL) the lamp is not inclosed, but the arrangement for conserving the heat is excellent; and although the Barler stove is a superior room heater, the Edwards device is effective, and in addition it affords a convenient and strong apparatus for boiling water or for light cooking, and is decidedly ornamental.

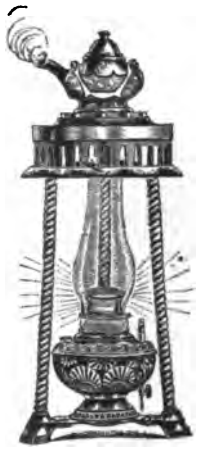


FIG. KKK.—The Edwards parlor lamp stove.

In the building of Sweden was shown an excellent oil vapor lamp devised by J. V. Svenson, which gave a very hot blowpipe flame, useful for soldering as well as for boiling water and cooking. A description would require illustrations which are not at hand. In the same building was shown a form of gas or petroleum stove for warming houses which is much used in Sweden. The products of combustion pass between double walls to the top of the stove, then downward, and finally to the chimney.

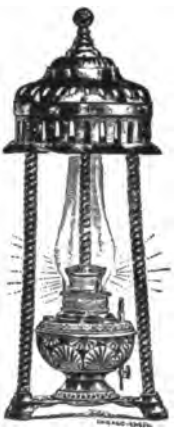


FIG. LLL.—The Edwards parlor lamp stove.

Not much is to be said of the exhibits of gasoline or vapor stoves, the improvements in these being more in the designs than in the methods of burning the fuel and conserving the heat.

The Dangler Stove and Manufacturing Company, of Cleveland, showed a somewhat elaborate burner, which they designate the "Surprise," which is already largely used.

The largest exhibit of vapor stoves was made by George M. Clark & Co., of Chicago.

Among makers of gas stoves and ranges, the Milwaukee Gas Stove Company exhibited the best as regards the kinds of burners used and in the manner of applying the heat to ovens. It may be a question whether the bored or sawed burners are the more effective heaters,

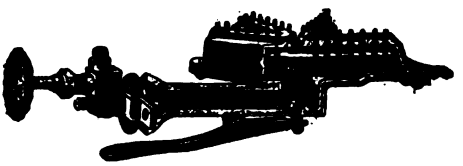


FIG. MMM.—Sectional view of Perfection burner.

but certainly for domestic use the advantage will lie with the burner that is most easily kept clean and will burn the gas without odor. The cleaning device of the "Perfection" burner, shown in figure MMM, is convenient and effective, and the needle valve (fig. NNN), which adjusts the proportion of gas and air at any pressure, is most excellent.

Messrs. F. & L. Kahn & Bros.

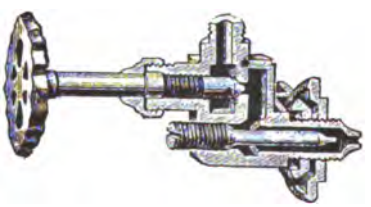


FIG. NNN.—Sectional view of Perfection needle valve.

showed another form of burner having removable tips for cleaning, and the arrangement for heating water on their gas ranges was the best shown, but there is still opportunity for very great improvement in the use of gas for this purpose.

FIG. OOO.—Perfection range, No. 18.

Messrs. George M. Clark & Co. made a good display of gas stoves, but they possessed no particular features of novelty.

RAPID WATER HEATERS.

The Instantaneous Water Heating Company, of Chicago, exhibited their water heaters in practical operation in the Manufactures building. The device is a gas heater, in which the water is very quickly heated, to boiling if required, as it flows in a thin sheet over the surface of a conical drum within, at the bottom of which are gas jets.

This is a convenient and comparatively economical heater, well made and of attractive appearance.

A somewhat heavier and more expensive but very excellent device is the "Lightning Geyser," exhibited in the British section of Machinery Hall by Messrs. Ewart & Son, of London. An experiment was roughly made to determine the amount of gas required to heat 30 gallons of water from 62° F. to 102° F. The gas consumed measured 16 feet and the experiment occupied eight minutes.

In the Russian section was shown a device for heating water for tea or domestic uses, well adapted to the requirements of the country where it is used. It was exhibited by Yassili P. Orloff, of Moscow. The fuel used is wood or coal, and the water is rapidly and very economically heated.

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